446-10

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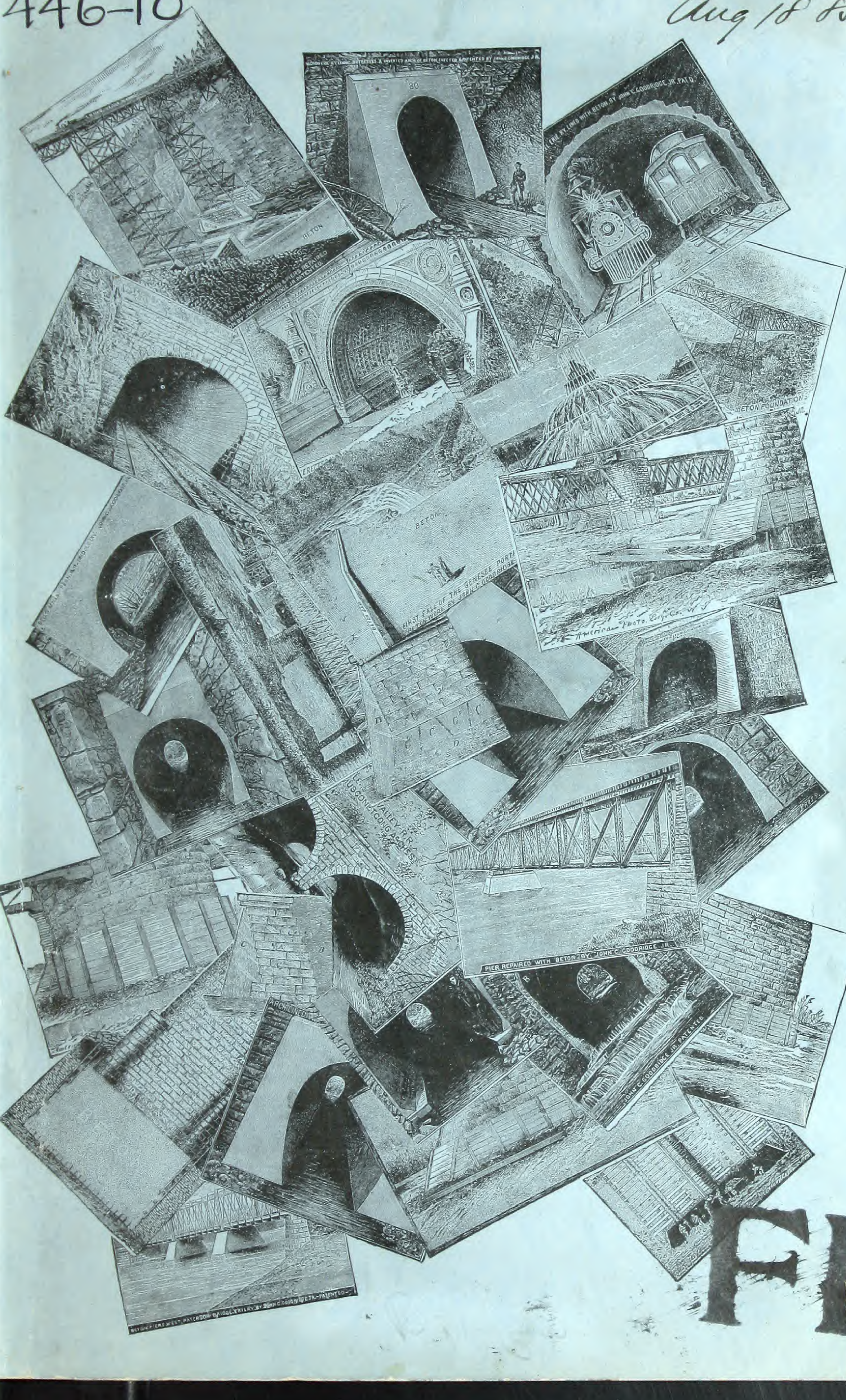


FI

Beton Coigner

—AND—

Goodridge System

OF CONSTRUCTING AND REPAIRING

Railway and other Structures.

With Claim of Patents in United States and Canada.

1885.

Address JOHN C. GOODRIDGE, Jr., President,

NEW YORK STONE CONTRACTING CO.,

113 *East 25th St., New York City.*

THE manufacture of Beton in this country was commenced in the year 1869. The illustrations show structures erected by us. Many of them have been up ten to twelve years.

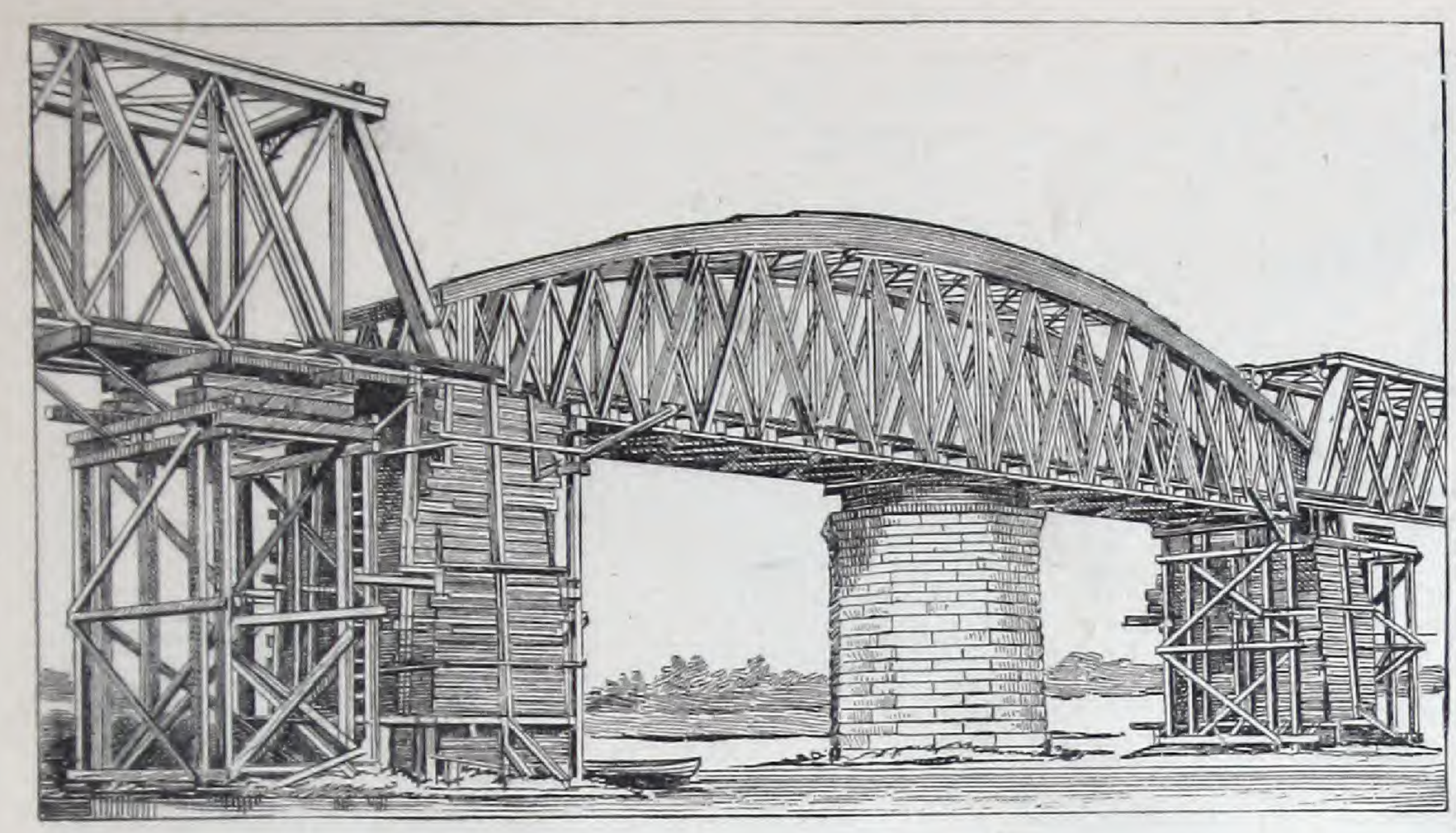
All have satisfactorily withstood all the tests that could be asked of any building material.

Beton commends itself particularly to engineers, from the fact that a structure can be made monolithic and homogeneous throughout its entire mass, while the rapidity of construction by this method is unequalled by any other. The process of repair can be carried on in arches and bridges without interruption of traffic.

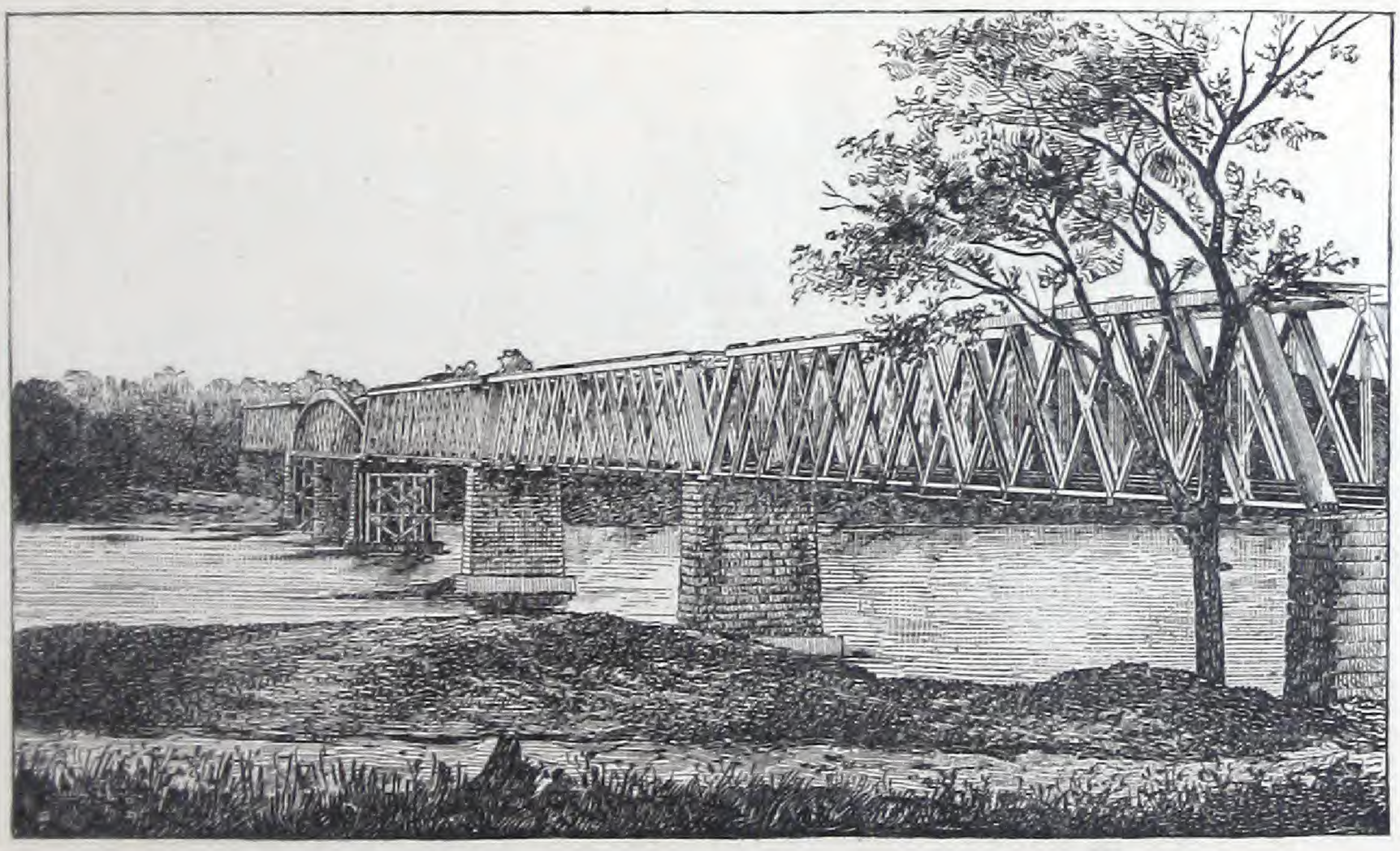
The claims of the Coignet and Goodridge patents are given as the shortest description of the process.

All persons are cautioned agaist infringing on these patents.

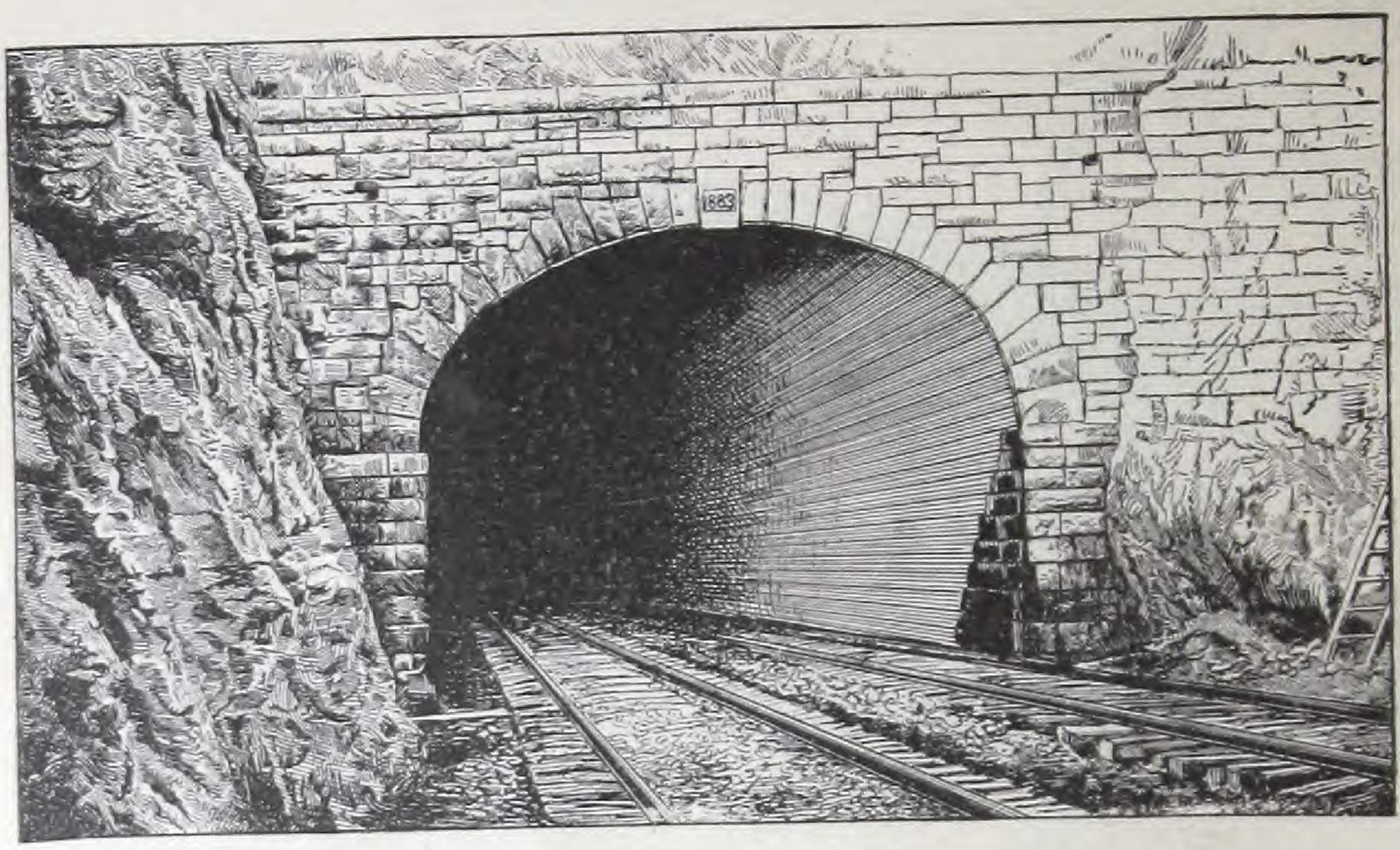
JOHN C. GOODRIDGE, JR.,
113 EAST 25TH ST., N. Y.



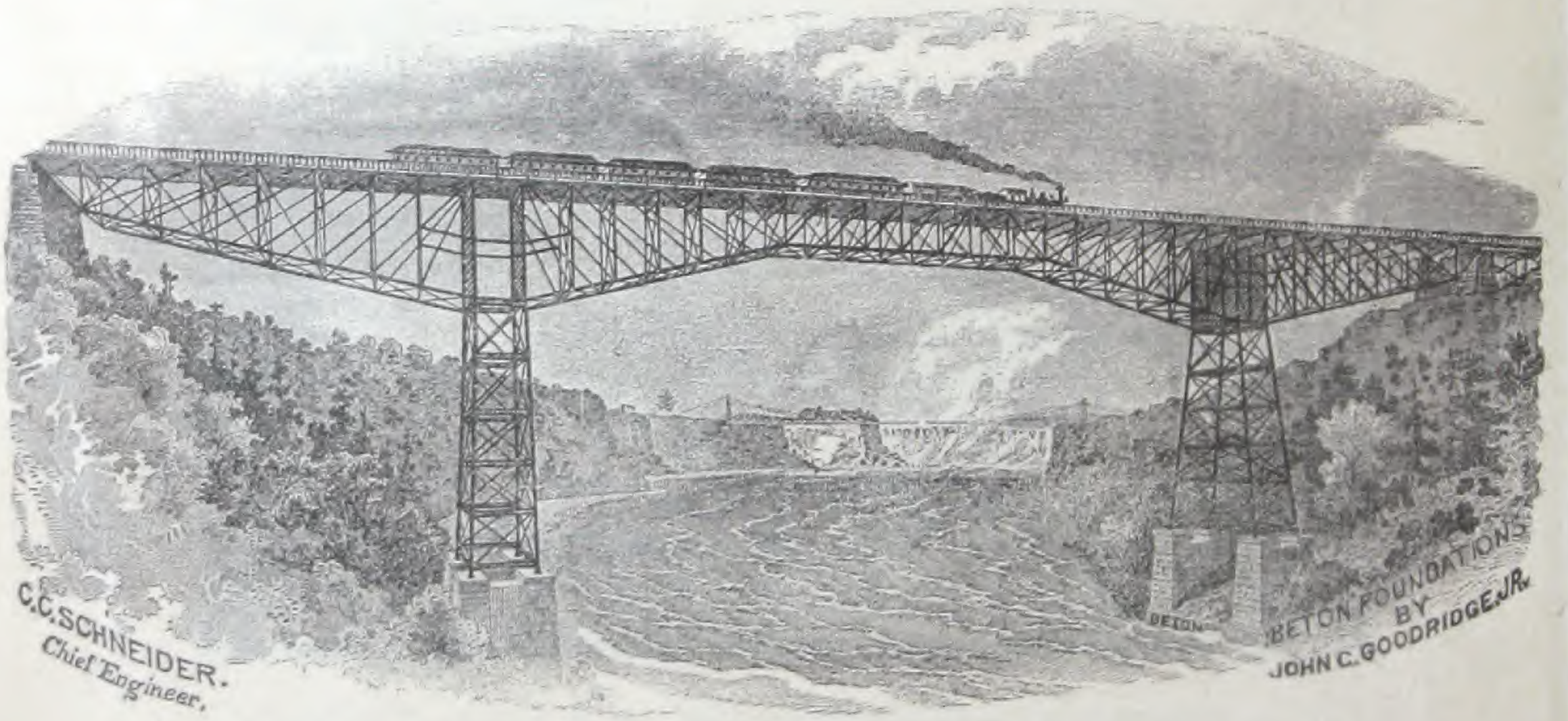
Draw Piers, Bridge at Montezuma, Ind., Wabash River, I., B. & W. R. R.
M. M. Defrees, Chief Engineer.



General View, Montezuma Bridge, Wabash, Ind. M. M. Defrees, Chief Engineer.



Haverstraw Tunnel, N. Y., Ontario & Western R. R. Walter Katte, Chief Engineer.



Cantilever Bridge, Niagara River. Central Bridge Company, General Contractors.

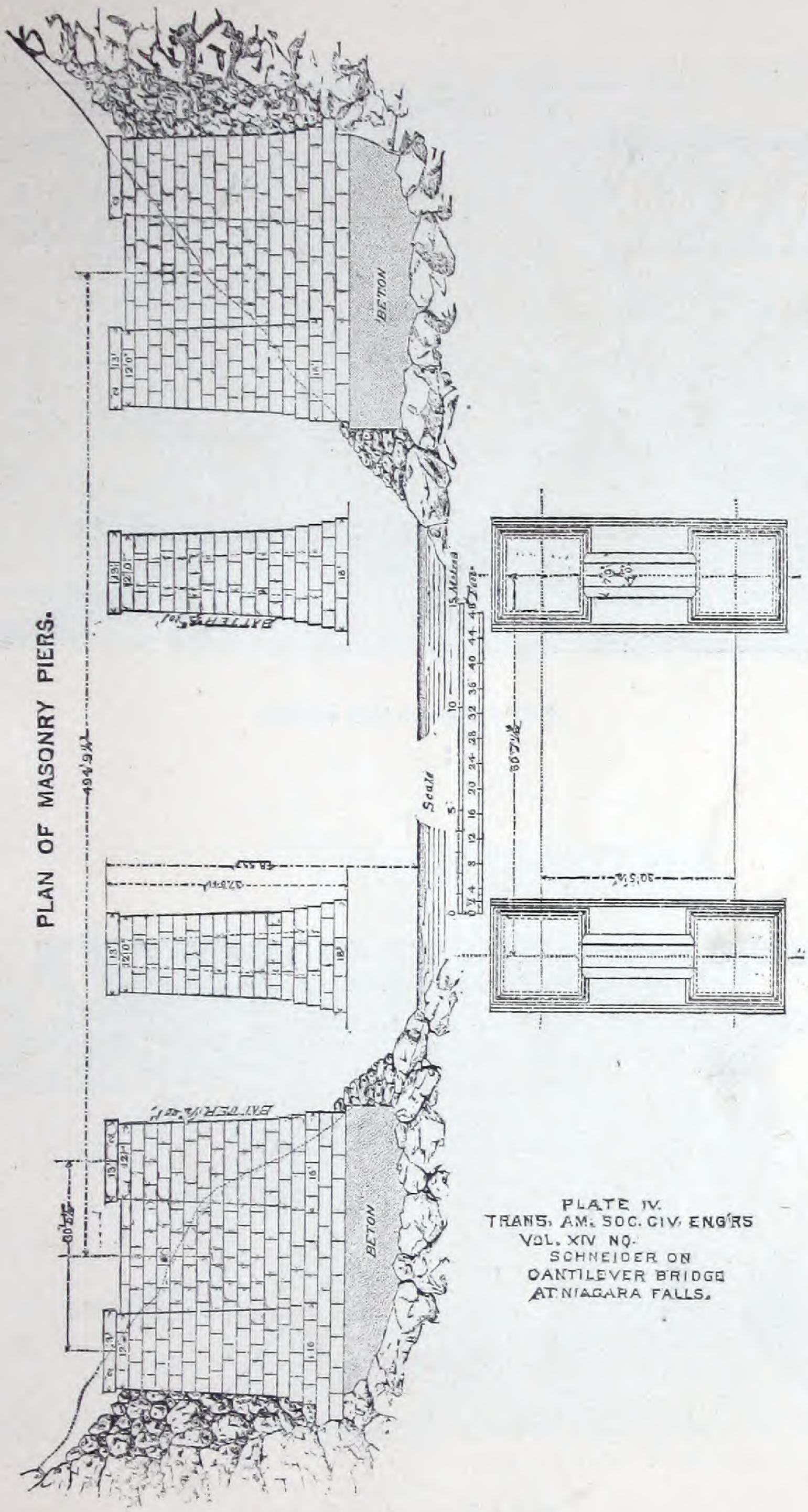
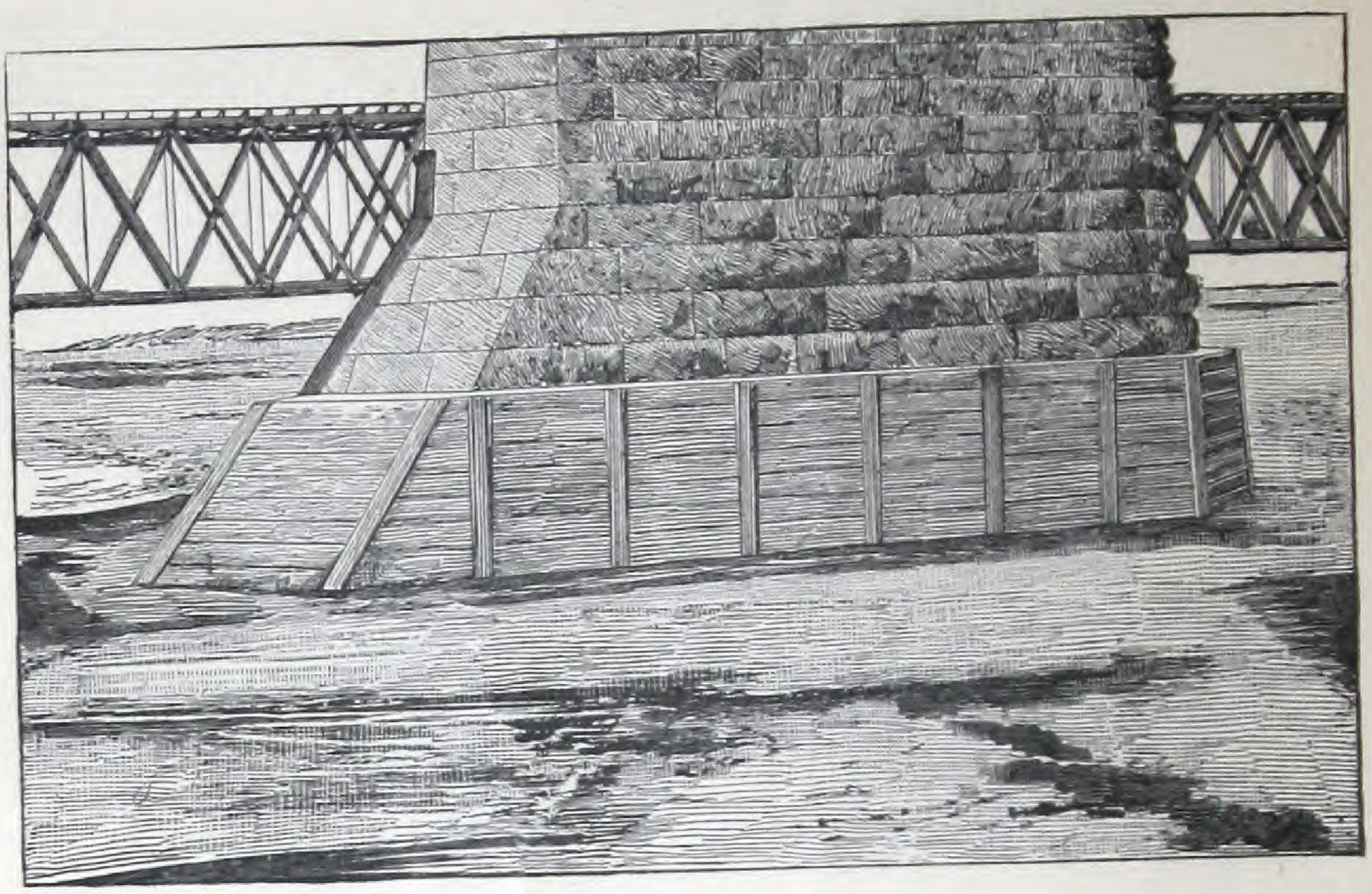
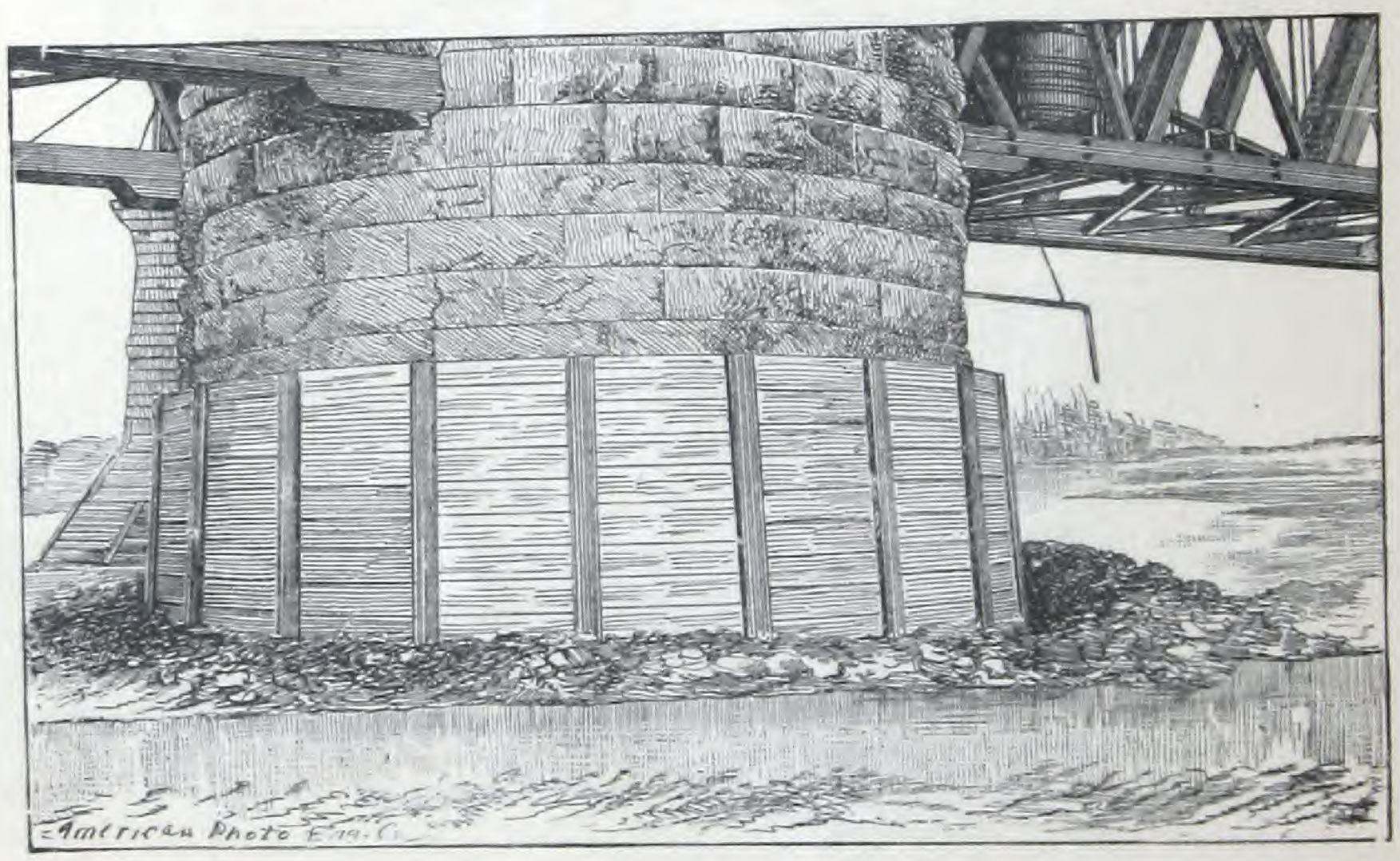


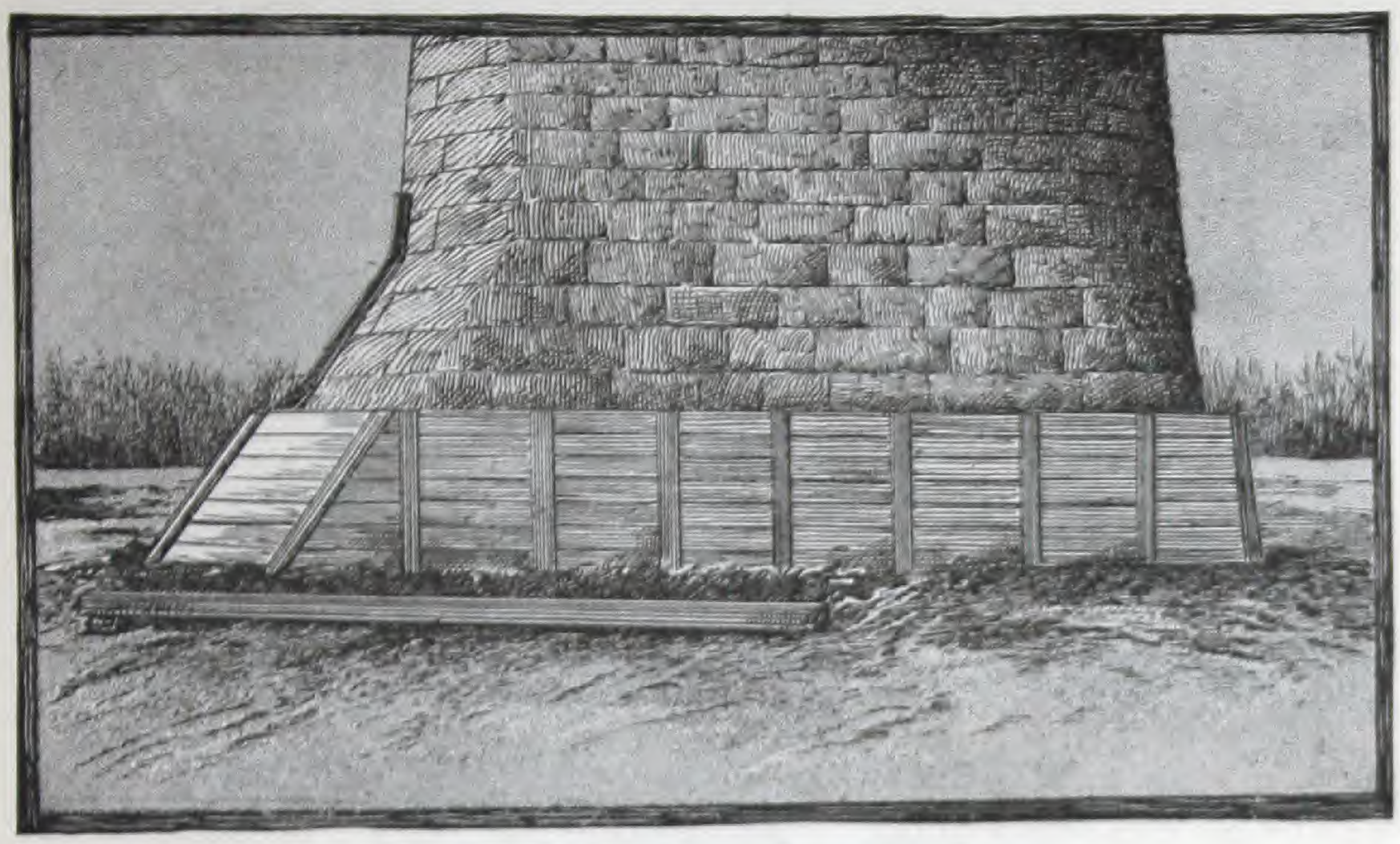
PLATE IV.
TRANS. AM. SOC. CIV. ENGRS
VOL. XIV NO.
SCHNEIDER ON
CANTILEVER BRIDGE
AT NIAGARA FALLS.



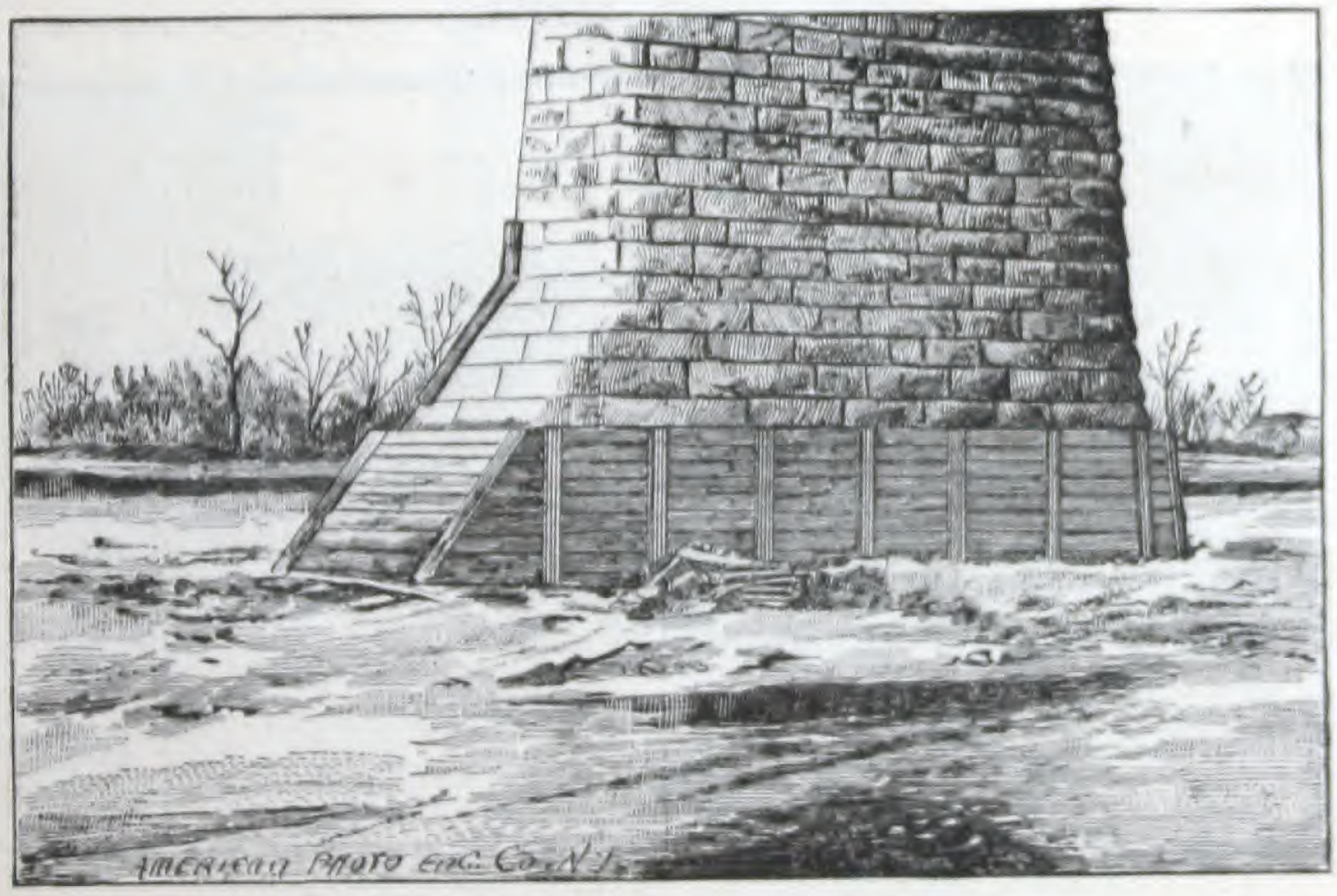
Pier 1, Kansas City Bridge.



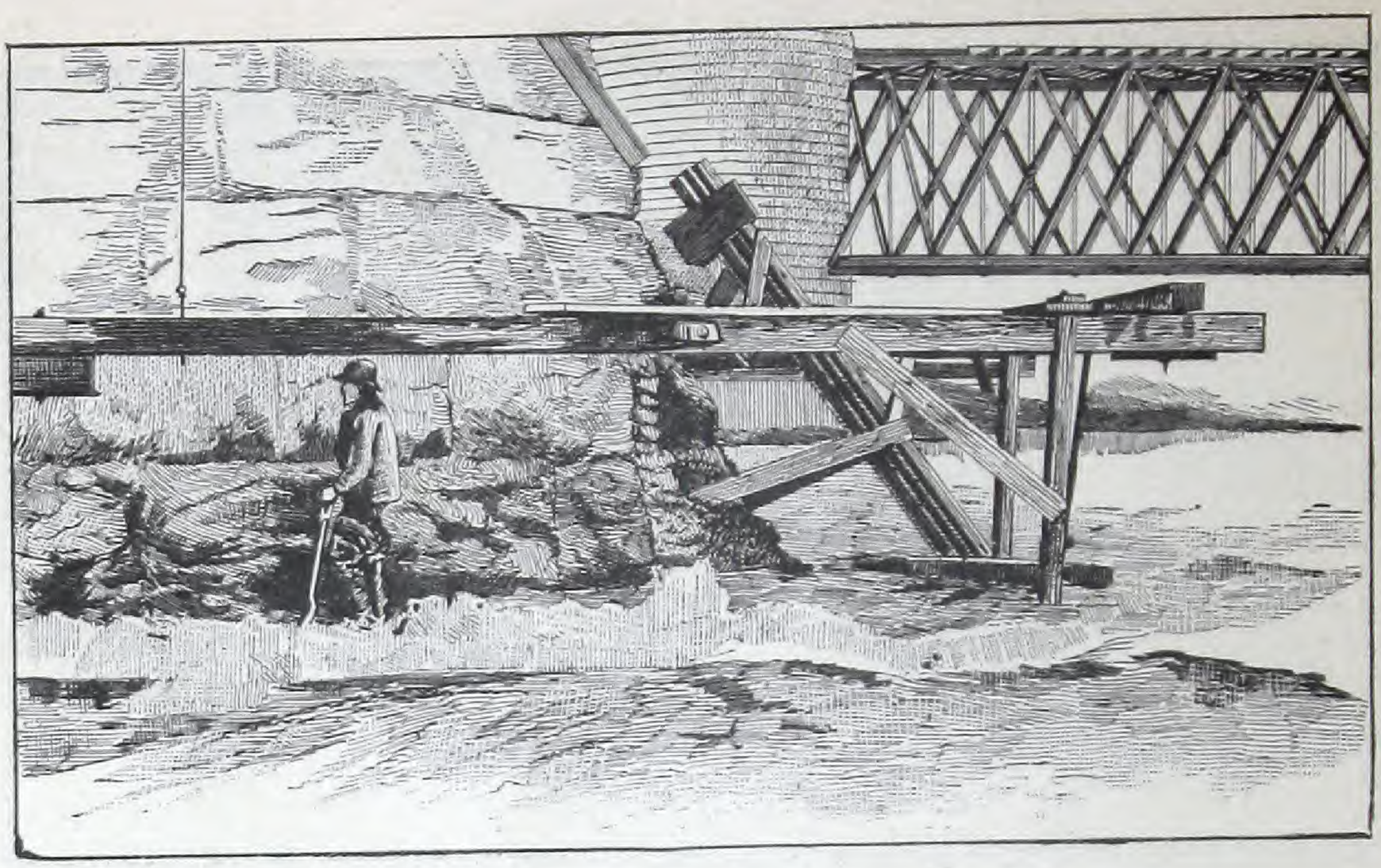
Pier 2, Kansas City Bridge.



Pier 3, Kansas City Bridge.

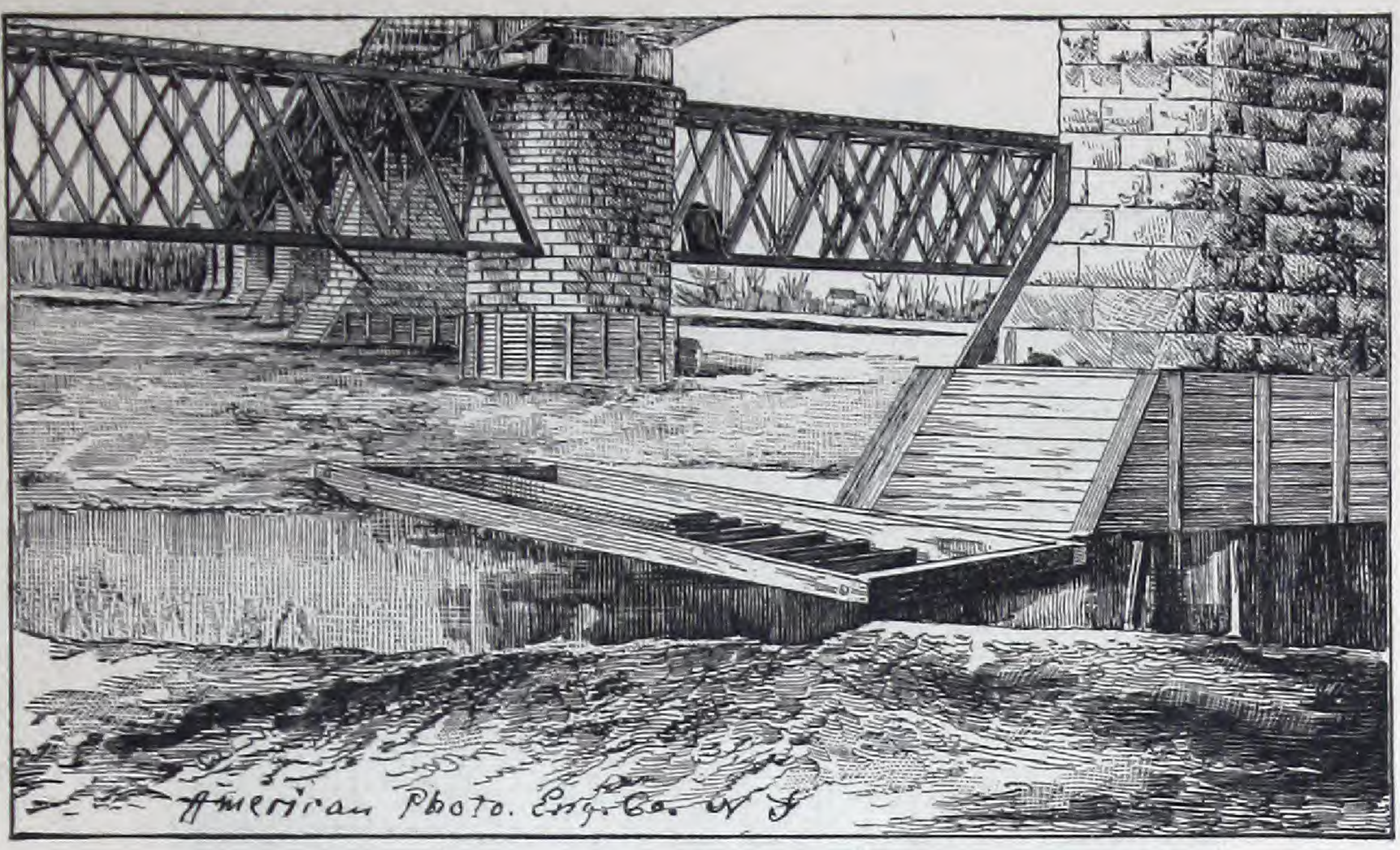


Pier 4, Kansas City Bridge.

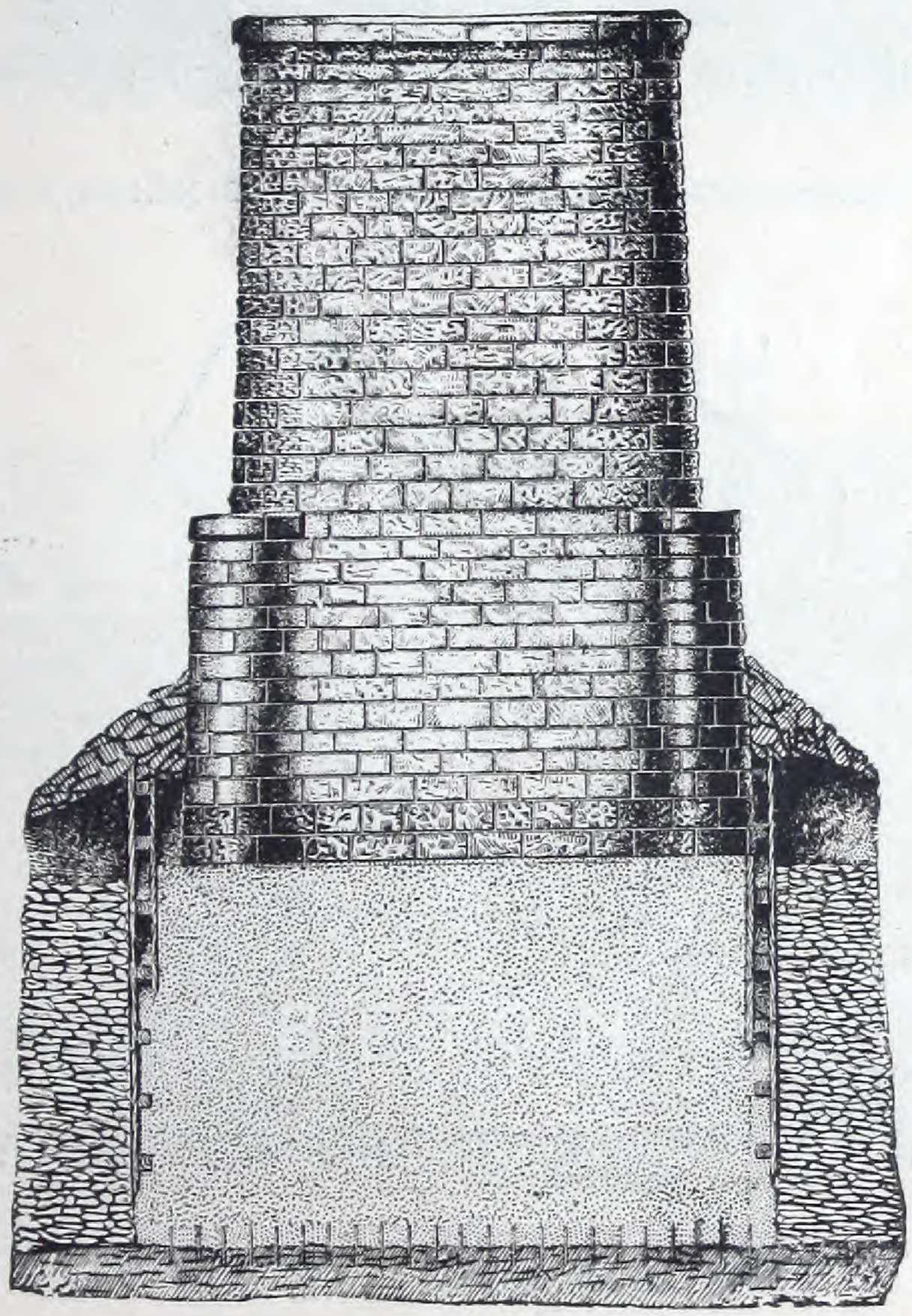


Pier 3, Kansas City Bridge, before Repairs

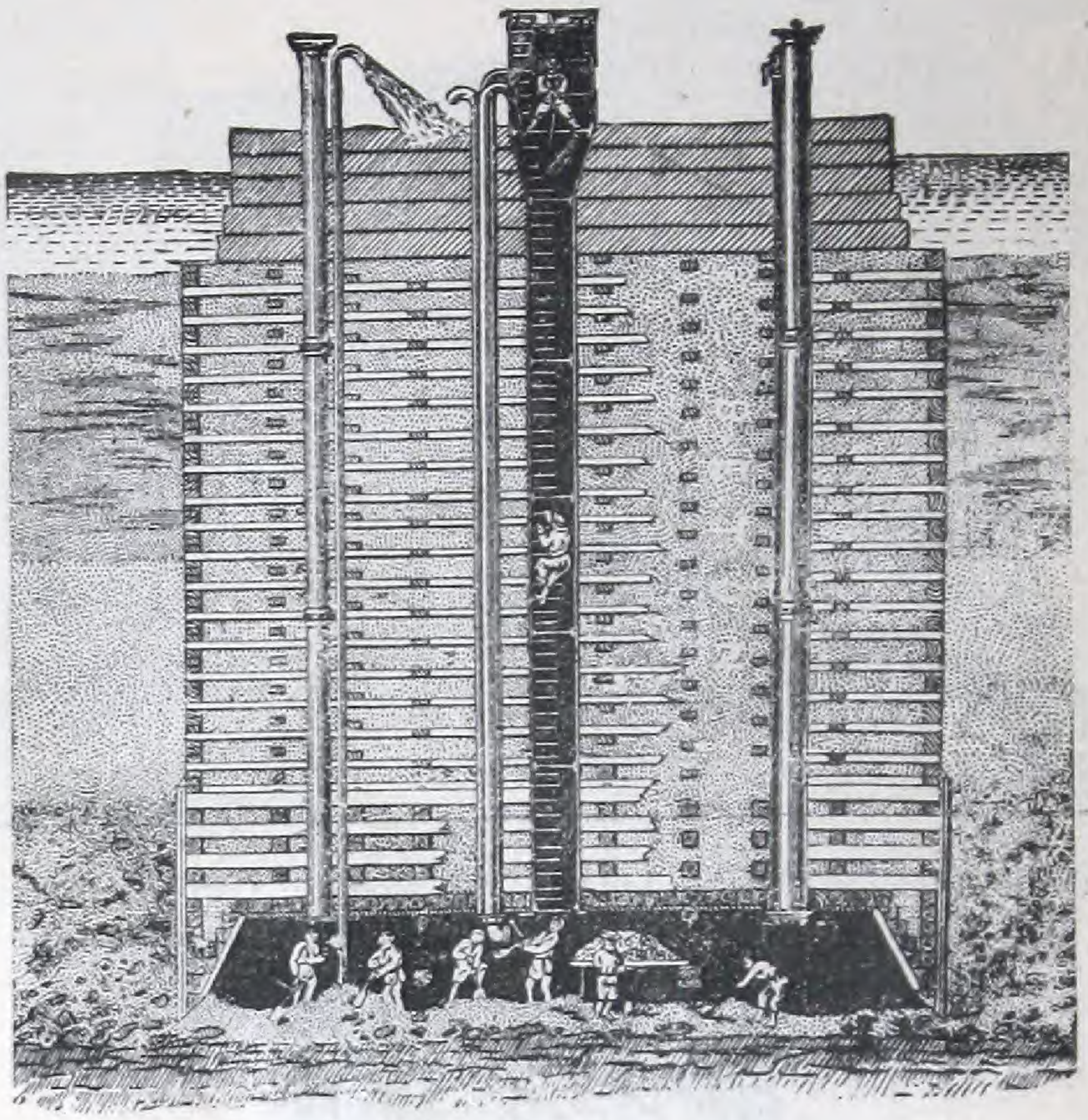
Pier 4, Kansas City Bridge, before Repairs.



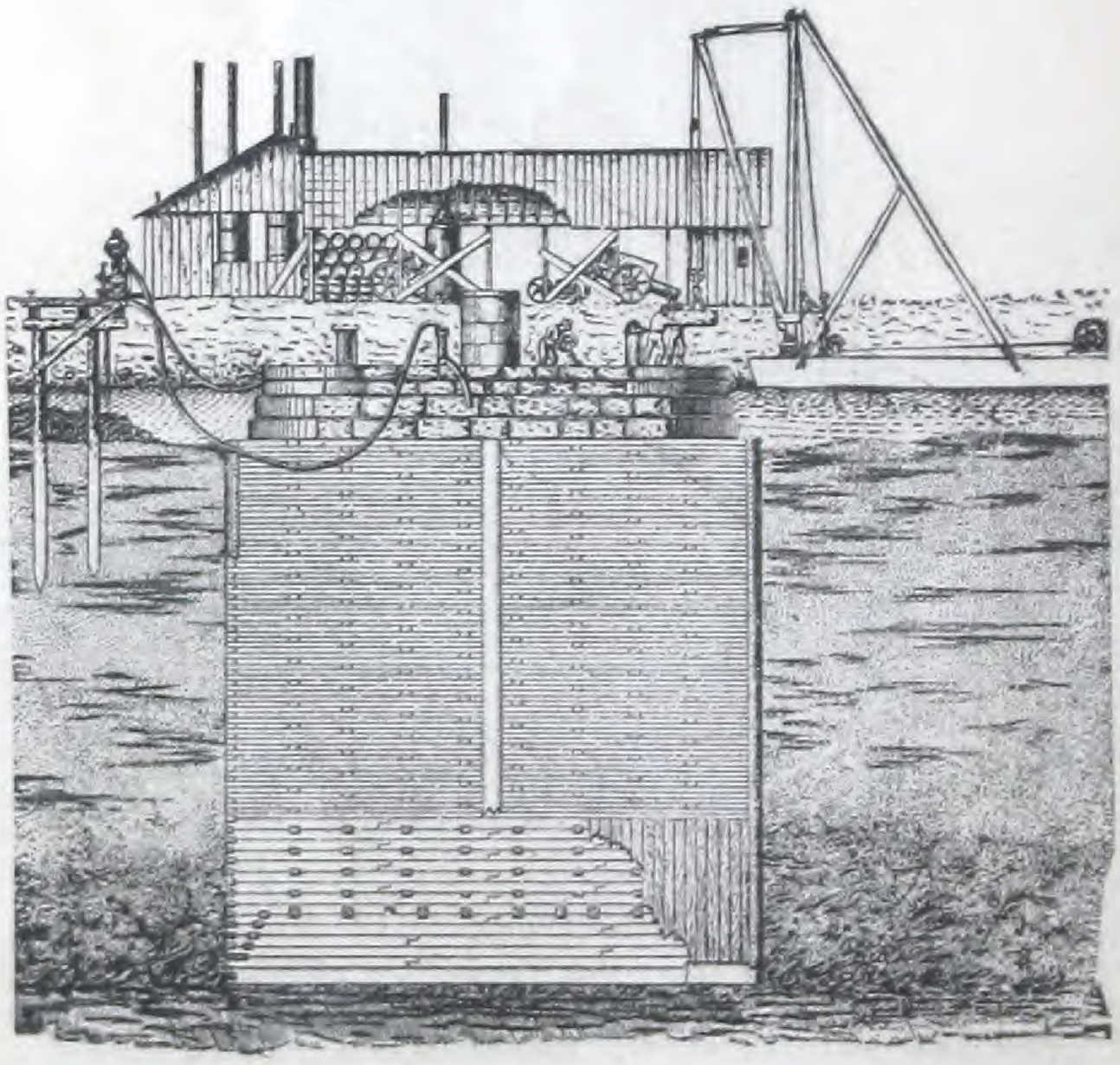
General View, Kansas City Bridge. Geo. S. Morison, Consulting Engineer. C. C. Chandler, Chief Engineer, Hannibal & St. Joseph R. R.



Plattsmouth Bridge, Missouri River. Geo. S. Morison, C. E.

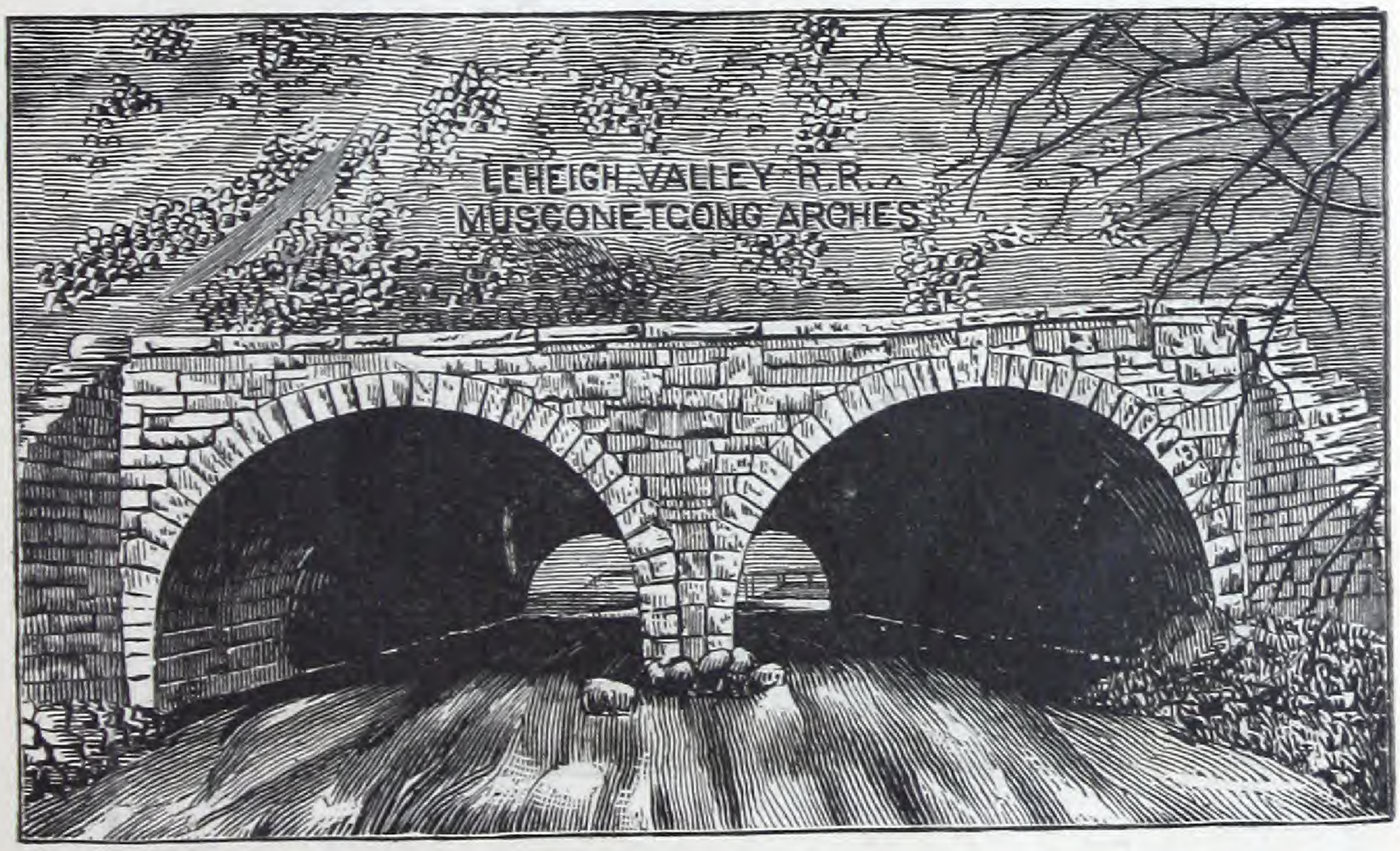


Plattsmouth Bridge, Missouri River. Geo. S. Morison, C. E.

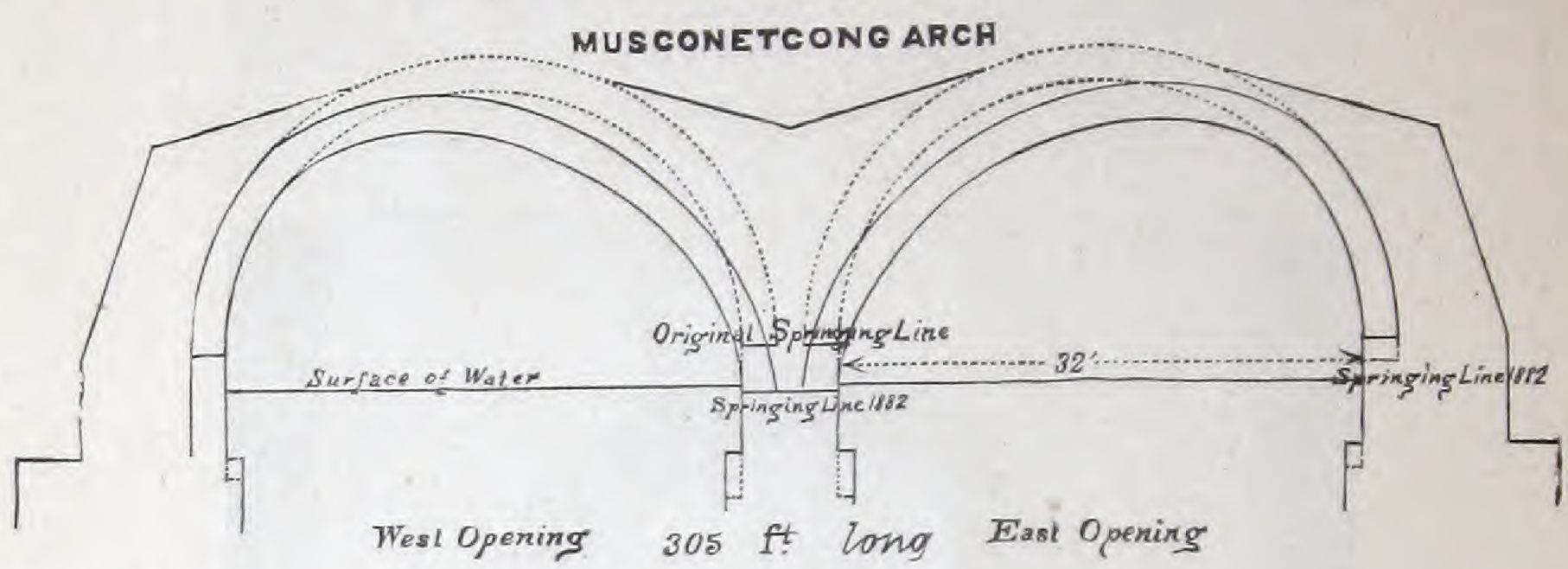


Beton Foundations of Plattsmouth Bridge, Missouri River.
Geo. S. Morison, C. E.

Pennsylvania Railroad



A. W. Stedman, Chief Engineer.



Section before Repair.

It is not intended to give recommendations or reports of engineers in connection with this process. The many structures erected or repaired since 1870 show for themselves, and are their own best recommendation; and to all of them, and to all the railroads and engineers by whom we have been employed, we respectfully refer. We make a few extracts from the "Transactions of the American Society of Civil Engineers," contained in a paper prepared by Mr. Chanute, when Chief Engineer of the Erie Railroad. It shows concisely some of the advantages of this process.

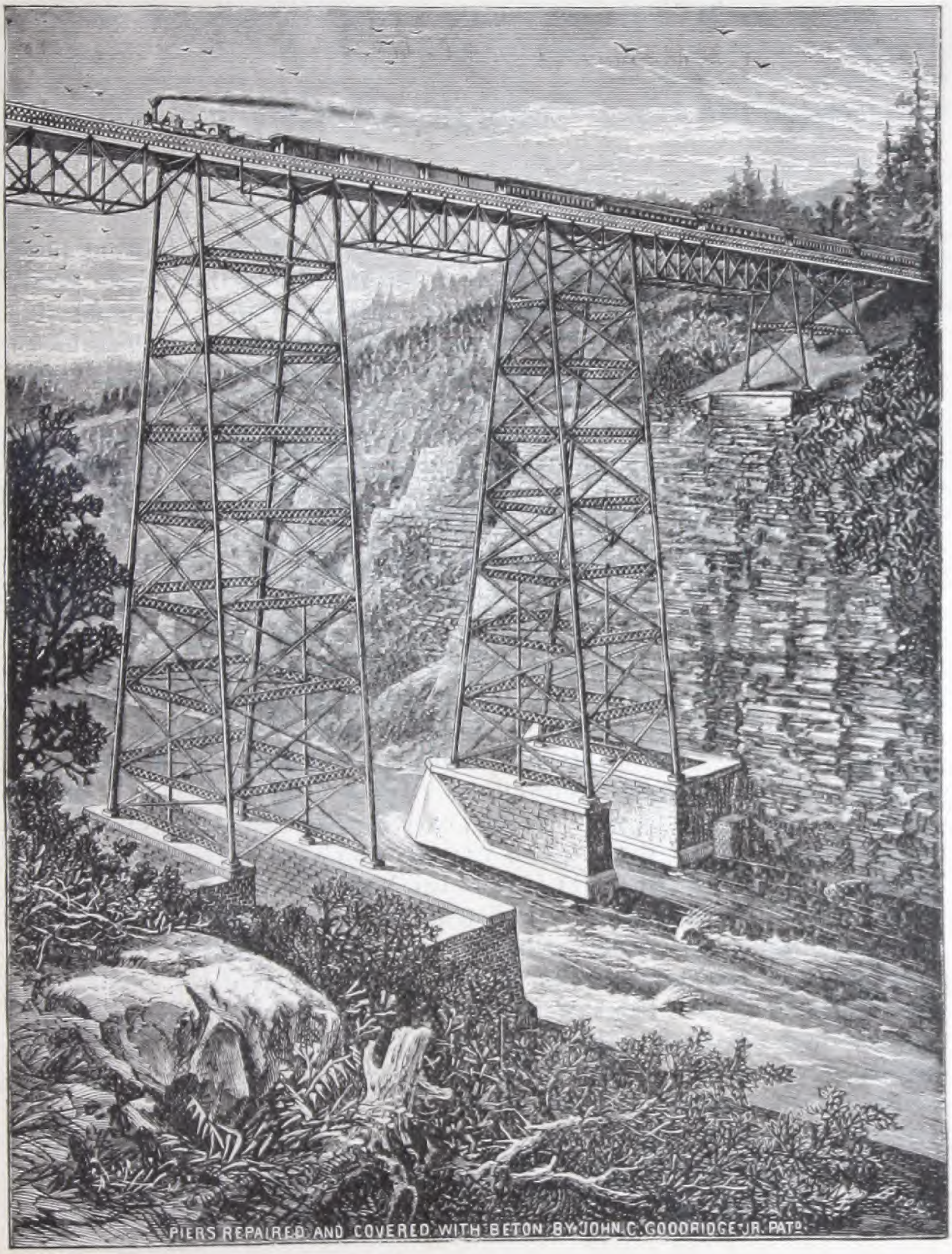


Fig. 1. Portage Bridge.

AMERICAN SOCIETY OF CIVIL ENGINEERS.

REPAIRS OF MASONRY.

By O. CHANUTE, Vice-President A. S. C. E.

Read at the 13th Annual Convention of the Society, June 15th, 1881.

The important economical results accomplished on the Erie Railway (now the New York, Lake Erie, and Western Railroad), within the last six years, by the use of béton, warrant making an exception to the general rule concerning methods which are protected by letters patent, and induce me to give an account of a material which is capable of extensive application by engineers.

Beton, when put into place, forms a plastic mass, capable of being rammed into crevices of all masonry, of being moulded to all shapes, and made into monoliths of all kinds and sizes, from a statue or obelisk to a culvert or viaduct.

When set, it becomes a hard and imperishable stone, with a tensile strength of some 300 pounds to the square inch, and a crushing resistance of about 8,000 pounds per square inch, or about as strong as good granite; and when well made of good materials, neither time nor the elements seem to have any more effect upon it than the ancient Roman mortar, which it resembles in its hardness and tenacity of adhesion to natural stones.

It is proposed to give an account in this paper of the uses to which beton has been applied on the Erie Railway.

In May, 1875, the Portage viaduct, over the Genesee River, on the Erie Railway, was burned down. This viaduct, which is 850 feet long, and 234 feet high above the bed of the stream, had been built of wood in 1852, and rested upon fifteen stone piers, from ten to thirty feet high. These piers were much injured externally by the fire, and when examined for the purpose of rebuilding upon them the iron viaduct which replaced the wooden one, they were found considerably shattered and shaken, in consequence either of bad workmanship, the perishable nature of the stone, or the settling of the foundations.

In order to save expense, however, it was determined to use these old piers, provided they could be protected from the further disintegrating effects of the weather; and investigation having pointed to the efficiency of beton for this purpose, it was determined to try it.

A contract was accordingly made with Mr. Goodridge, President of the New York Stone Contracting Company—this being the name of the organization which controls the beton process in this country—to repair these piers. This was done by encasing all portions exposed to the wash of water at the ordinary winter stage (which portions had been more or less shattered by frost and undermined by the action of water) with twenty-four inches of beton; the ice-breakers at the ends were also encased, and the tops of the piers were covered with a coat of beton two inches thick, to keep out infiltration, and the consequent splitting apart of the masonry. The new pedestal blocks for the posts were also boxed in with beton to keep them firm and sound.

By examining the engraving of the bridge, you can distinguish the portions of the piers covered with beton by their white, blank appearance. It is on top, on the shoulders of the ice-breakers, and along the base, next to the water.

The amount paid to the Stone Contracting Company for the beton work came to about $6,000. It would have cost $40,000 to have rebuilt the piers for the new iron bridge, and thus the saving was very large. The result has been very satisfactory. The piers have stood strains from the superstructure which would have shaken them all to pieces by this time if they had not been so protected.

The Warsaw Culvert.

Although the Erie Railway runs much of the way through a rocky country, few of the stones found along its line stand the weather. Many of the culverts, abutments, and piers have, therefore, been eaten into by the elements, and, in the course of years, not a few have been replaced by new structures.

When such culverts are under heavy embankments, their renewal involves the great expense and risk of digging them out, carrying the track upon temporary works, and rebuilding a new culvert and embankment under the trains.

In 1875 there was such a culvert near Warsaw, on the Buffalo Division, which threatened to fall into ruins. It was 146 feet long, fourteen feet in clear opening, and under an embankment sixty feet in height. The frosts had gnawed its bench walls and ring stones until they had become an irregular mass of crumbling flakes, which came down with the slightest touch. Some of the stones were entirely gone, leaving cavities from three to six feet long, and extending back from one to three feet from the original face.

This culvert was more or less injured throughout its whole length, and hung together, apparently, from the force of habit in those natural arches which form with time in thoroughly settled embankments. It would have cost about $36,000 to have digged it out and replaced it with a new structure, as had been done during the previous year with a similar culvert upon the Western Division; when the contractor for the beton process offered to put a new face on the matter for $2,200. In view of the results already accomplished at Portage, the offer was accepted.

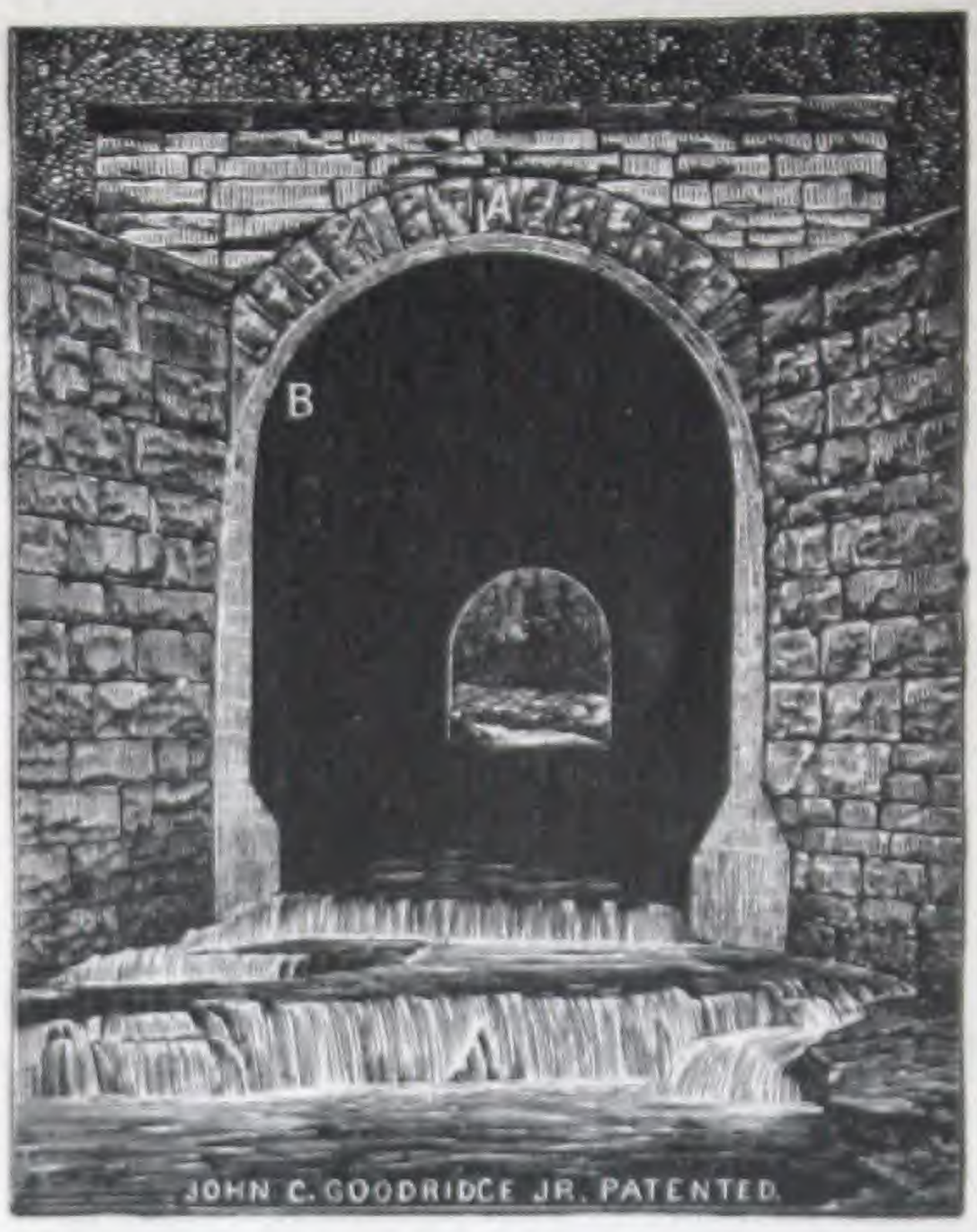


Fig. 2. Warsaw Culvert.

One week after the completion of the work the centres were struck; and when removed, together with the lagging, the inside of the culvert presented a hard smooth surface (except the saw marks and joints in the lagging plank, which had been faithfully moulded by the beton), and the work appeared to be entirely impervious to water.

A photograph of the end of this culvert will be found reproduced in Figure 2. *A* is the original arch, and *B* the beton lining, which has thus far stood perfectly.

It was thought, however, that perhaps the winter of 1875 had been too mild to test the material severely, and that another season would bring different results, and show some defects or weak points in this method of saving money in the repairs of masonry. No further work of this kind was, therefore, done in 1876, and in the spring of 1877 a new examination was made of the Warsaw culvert to detect any possible injury. None whatever was found, but it was then, and is now, after a winter as severe as heart could wish, as perfect as when originally built.

The Clifton Culvert.

In the spring of 1877 it was reported that a culvert at Clifton, 12 miles from Jersey City, needed to be rebuilt. It had originally been constructed of

red sandstone from the quarries in the vicinity, and was not only dilapidated and peeled by the weather, but it had settled upon its foundation, so that it was in a very dislocated and disjointed condition. Its wing walls had parted from its main walls, the parapet had been pushed out by the thrust of the earth so that it partly overhung the arch, and, singular to relate, it being under a shallow bank, the vibrations of the trains acting upon the earth that pressed against the culvert had actually lengthened it, so that its barrel was two feet longer than originally built. We know this to be a fact, for we found the original record plan, we measured the culvert carefully, and found enough openings in the joints fully to make up the two feet it had lengthened.

It would have cost $6,000 to have rebuilt this culvert but a contract was made to repair it for $600. This was done by lining it with an inside ring of beton, 4 inches thick, rammed into all the crevices and joints, and building

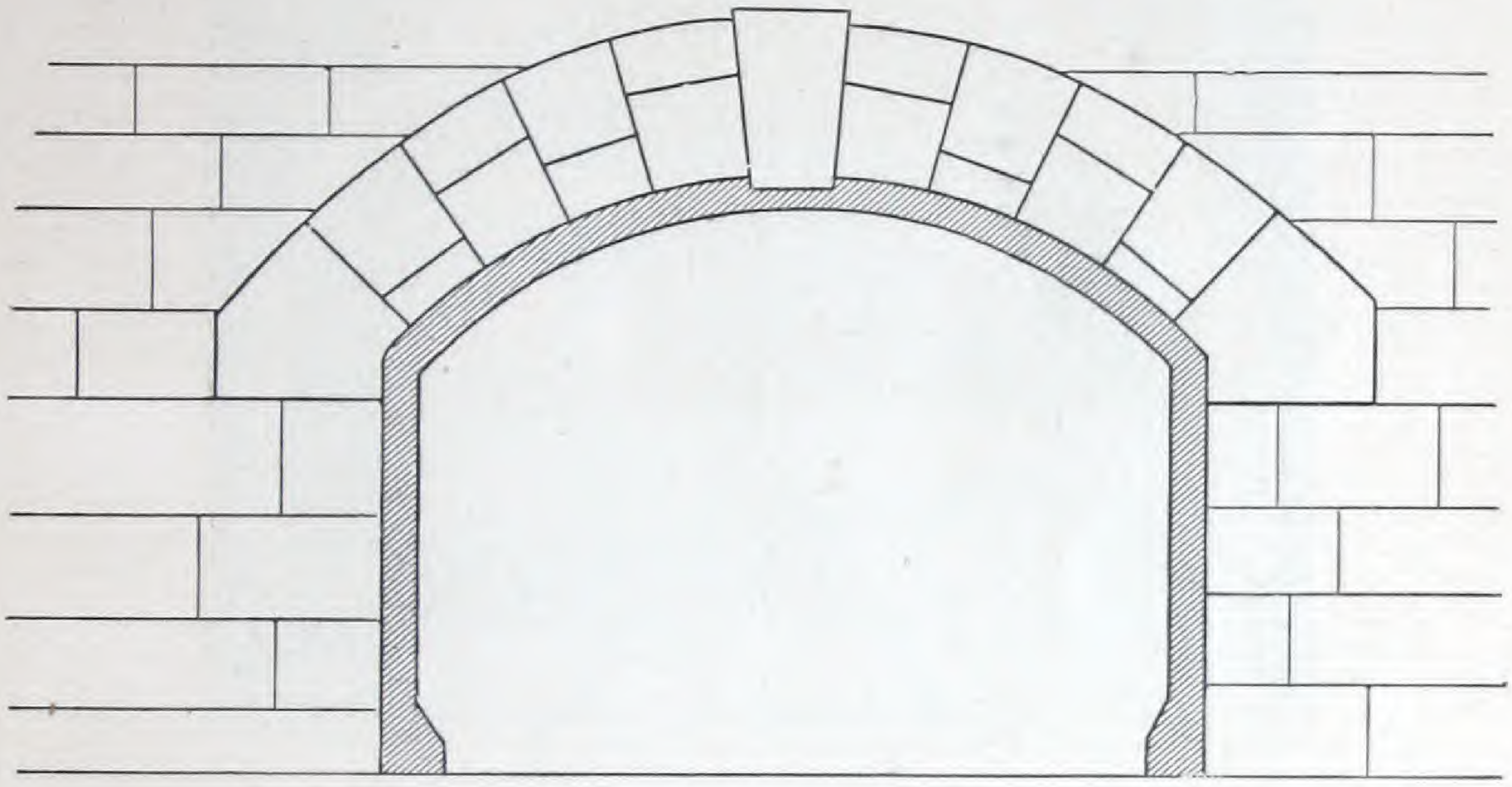


Fig. 3. Clifton Culvert.

beton buttresses at the ends, to prevent any further creeping away of the structure from under the trains. The success has been complete, and the culvert is now as good as new. A geometrical end view of it is given in Figure 3.

Bergen Tunnel.

In the fall of the same year it became necessary to make some repairs to the Bergen Tunnel at Jersey City. This tunnel is 4,316 feet long, and driven through trap rock. This, although very hard, and unaffected by the weather, is full of seams and faults, and being entirely unstratified, it comes down in blocks of isolated stones, which set dangerous traps for the trains. Some portions had been arched from time to time, but this had been done with brick, and, in the course of years, alternate freezing and thawing had peeled off the face from the bricks, generally in flakes about one inch thick, until in some places the arching had been eaten into for a depth of eight inches.

It was decided to arch over additional sections, where the naked trap rock was badly shattered, and to reline with a thin coating of beton another section in which the bricks had been most injured.

This was done by erecting iron centres, so arranged as to clear the trains, placing on the centres wooden lagging plank, and ramming the space between them and the face of the rock or brick full of beton, the latter being mixed on cars in the tunnel.

This work was all done at night, in order to have the least annoyance from trains, of which some 200 pass through every twenty-four hours.

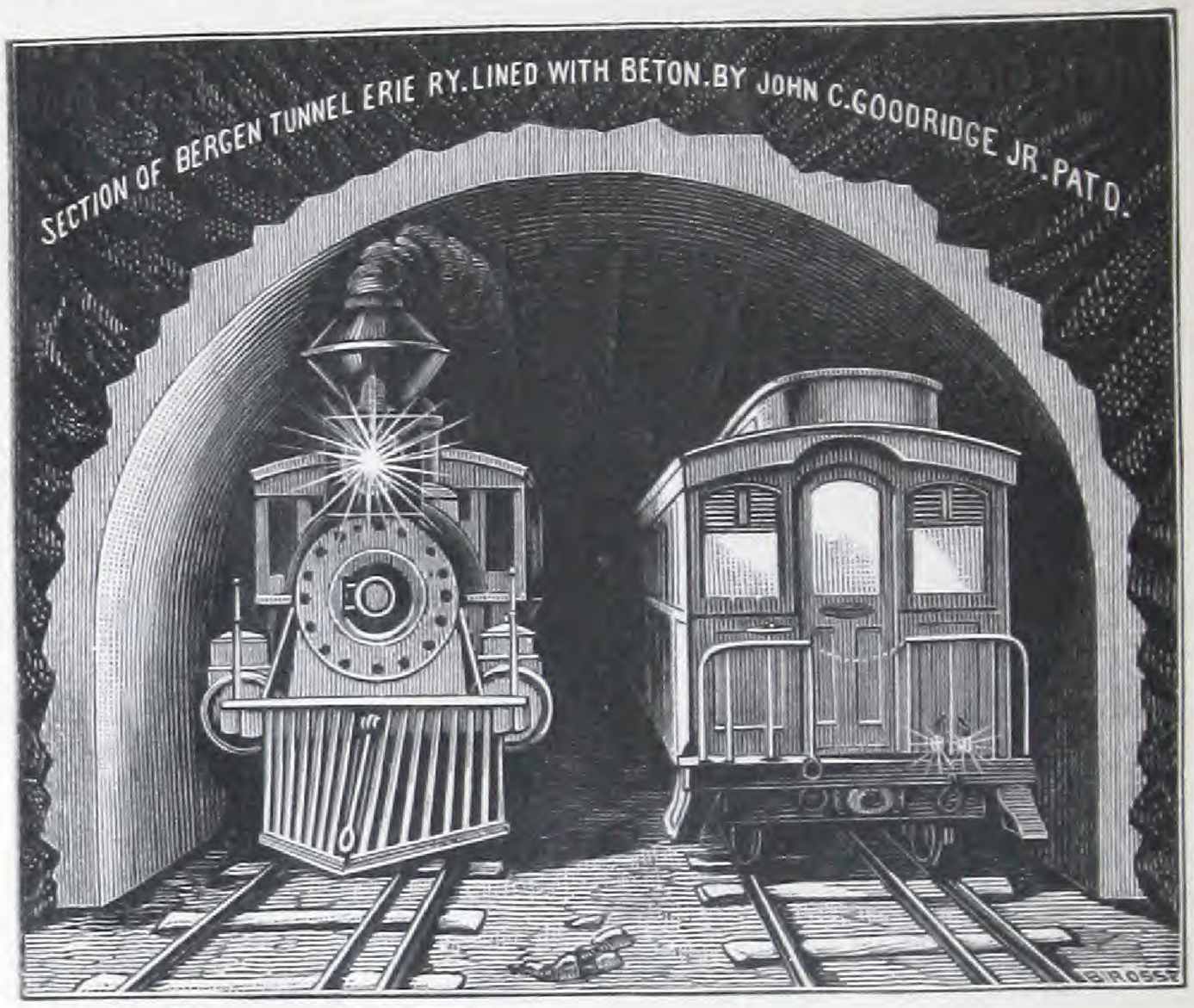


Fig. 4. Bergen Tunnel.

Figure 4 represents a section of that portion of the tunnel in which the beton was applied to the rock. When an infiltration of water was struck, in order to drain it, and prevent the formation of stalactites of ice which hang down (and fall down) every winter from the rock, drain tubes were left in the beton by inserting hollow blocks made at the factory.

The work was successfully accomplished, and has stood perfectly ever since.

Buffalo Division Culverts.

Thoroughly convinced by these successes, a further contract was made in 1878 to repair, by the same means, a number of culverts on the Buffalo Division, which were getting into the same condition as the one at Warsaw, which I have described.

The following is a list of them:

No. of Culvert.	Length in Feet.	Span in Feet.	Crown of Arch to Foundation. Feet.	Height of Embankment, Base of Rail to Bed of Stream. Feet.
80	147	10	17	87
3	141	10	12½	62
112	118	6	7	72
100	100½	6	9	39
4	112	10	13	63
77	52	6	10	28
101	46½	5	8	24
104	52	5	8	24
105	46	5	8	24
49	65	6	9	33
51	87	5	8	32
54	71	6	9	34
73	117	6	8	48

These 13 culverts, which had been built in 1851–52, had been nursed for some years, and exhibited all the ills to which masonry is subject in its old age. The stones were disintegrated, portions had caved in, the foundations were undermined, the bench walls were broken-backed, the arches were distorted, and the ends and parapet walls were thrust out. These were repaired with appropriate doses of beton.

Figures 5 and 6 show the end of culvert No. 101, and Figures 7 and 8 the end of culvert No. 4, before and after repair.

I regret that I cannot show you also photographs of the interior of these culverts, to exhibit their other defects. These were much worse than those shown.

Fig. 5. Culvert 101. Broken.

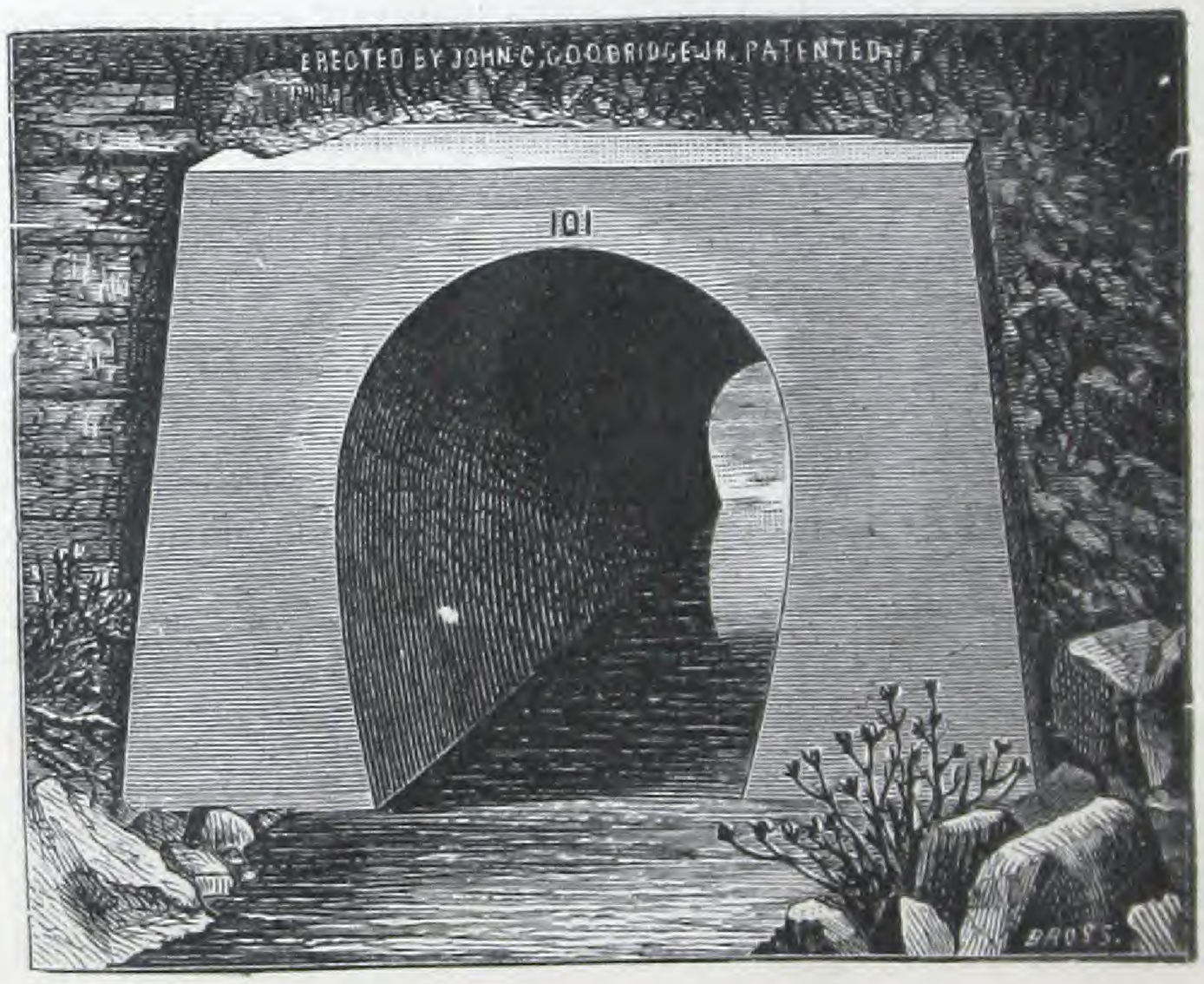


Fig. 6. Culvert 101. Repaired.

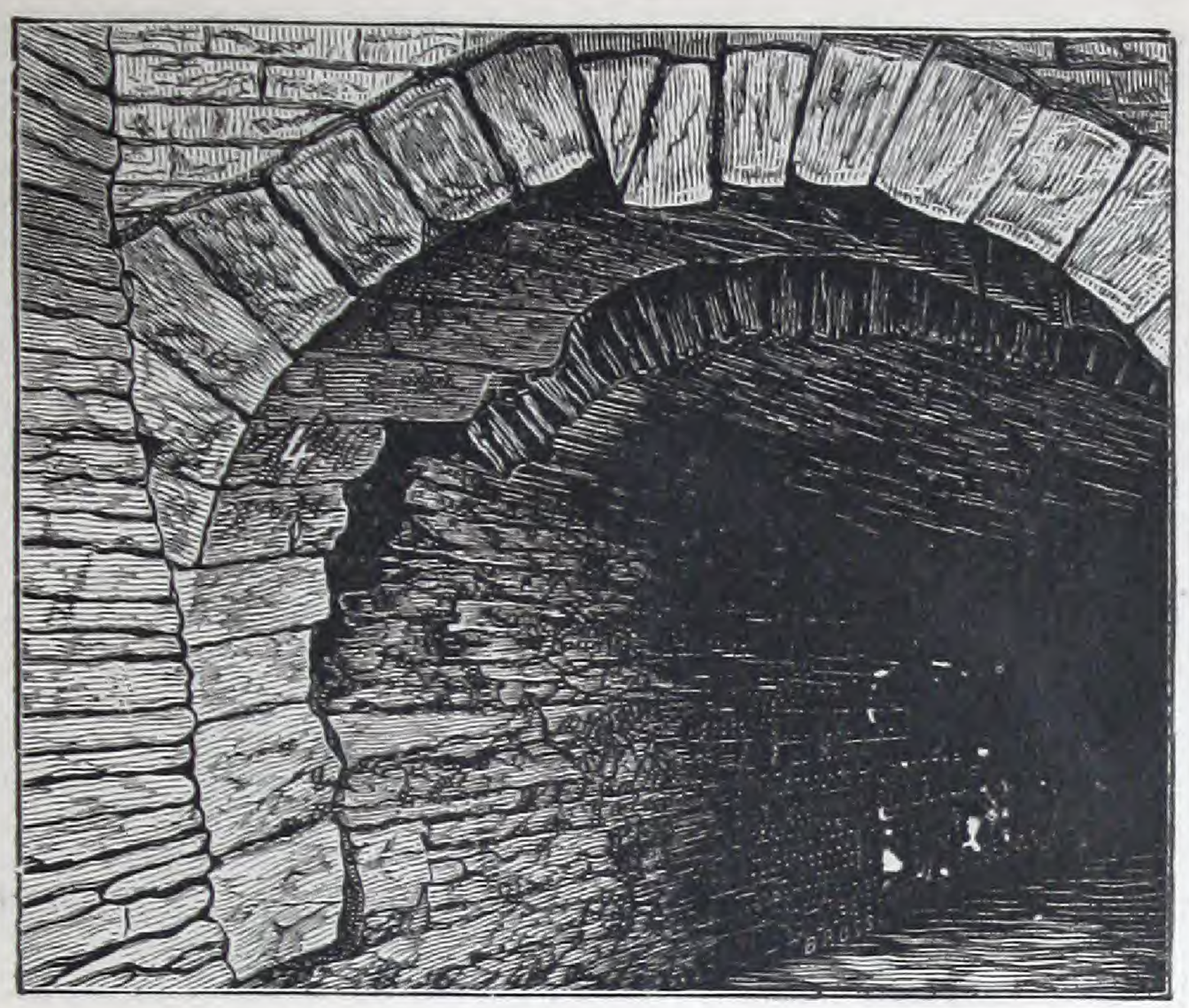


Fig. 7. Culvert 4. Broken.

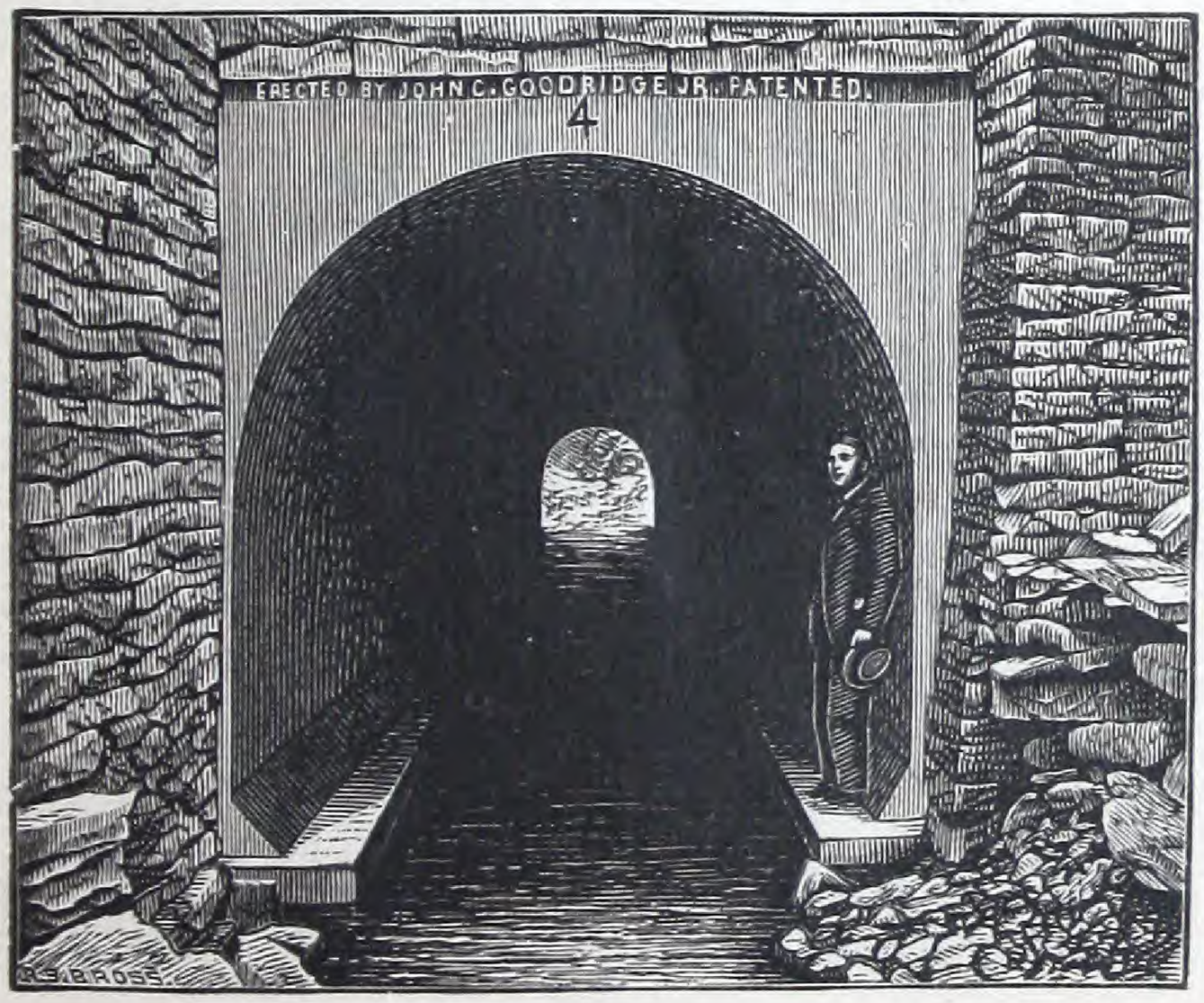


Fig. 8. Culvert 4. Repaired.

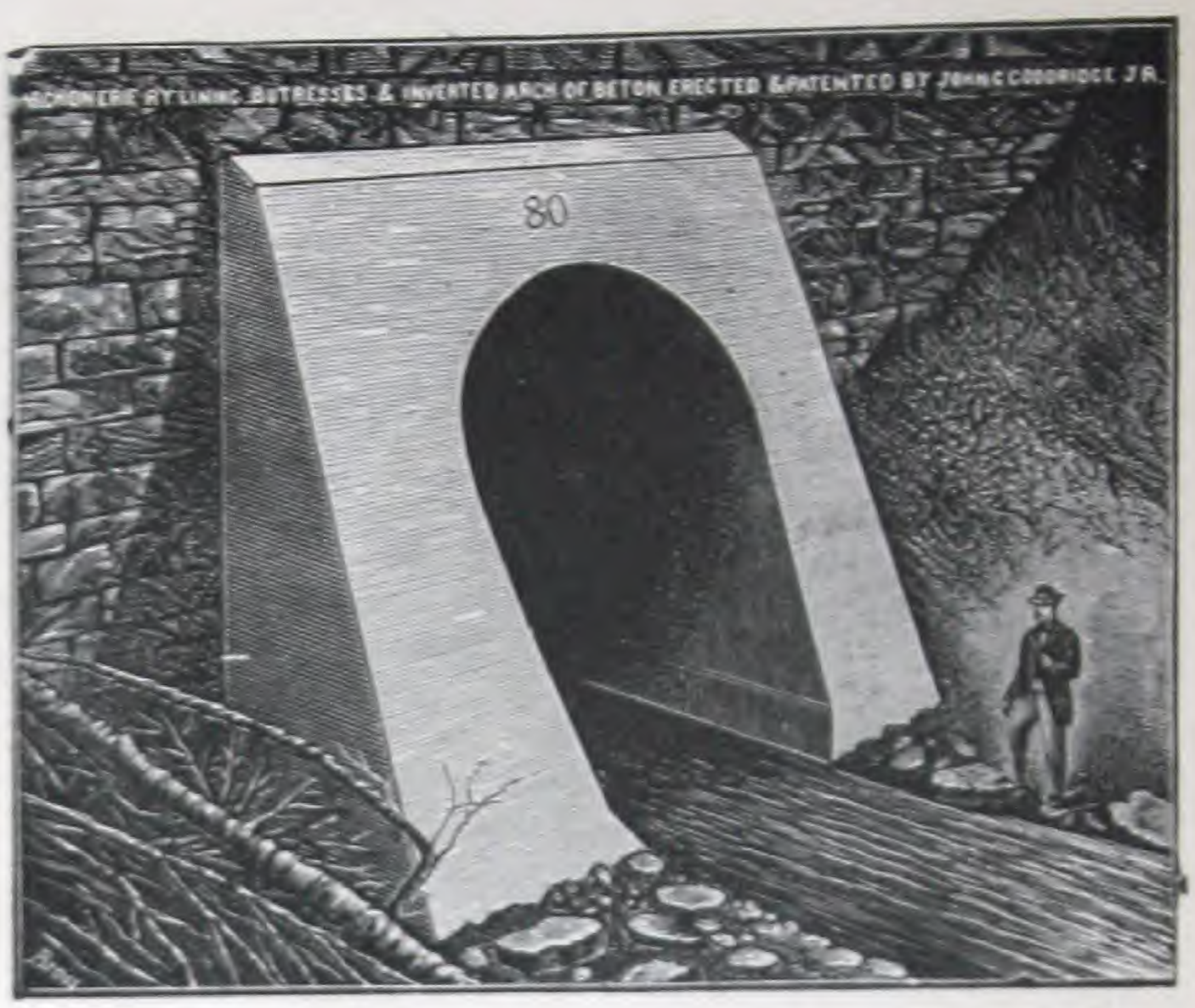


Fig. 9. Culvert 80. Repaired.

Figure 9 shows how beton buttresses were applied to culvert No. 80, which is built on a slant on a sloping bed of shale, which disintegrates with the weather. An invert, partly shown in the cut, was put in to prevent further injury.

Figure 10 shows a similar invert in culvert No. 112. The middle of this had caved in, and the arch was distorted. This culvert was 118 feet long.

Figure 11 shows the new form given to culvert 105, in which the ends were down, and the interior much injured.

In all cases, in repairing these culverts, all the loose mortar was picked out of the joints, the loose flakes of stone were knocked off, and the beton was rammed into all the holes and interstices.

We estimate that it would have cost to dig out and trestle these culverts, some of them being, as will be seen by the table, under embankments from 60 to 80 feet deep, and to have rebuilt them with new masonry, at say $10 a yard, the sum of about $80,000. We paid the contractor for repairing them $15,112.45, and we estimate that the labor of our carpenters, making and erecting centres, the free transportation of men and materials over the road, etc., etc., may have amounted to $5,000 more, so that the aggregate cost to the railroad was about $20,000.

The economy of the process was, therefore, marked and monotonous. All the culverts have stood perfectly ever since.

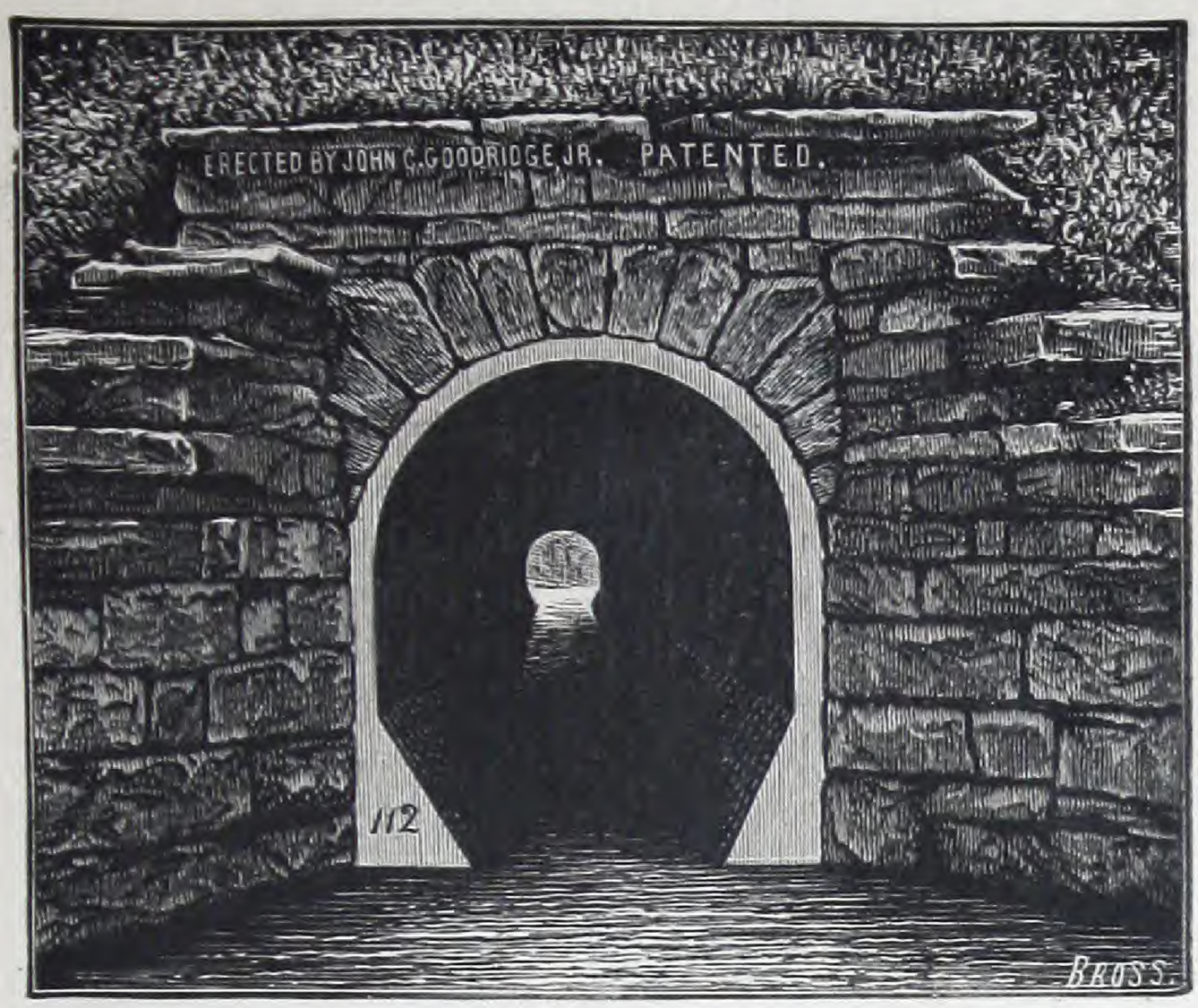


Fig. 10. Culvert 112. Repaired.

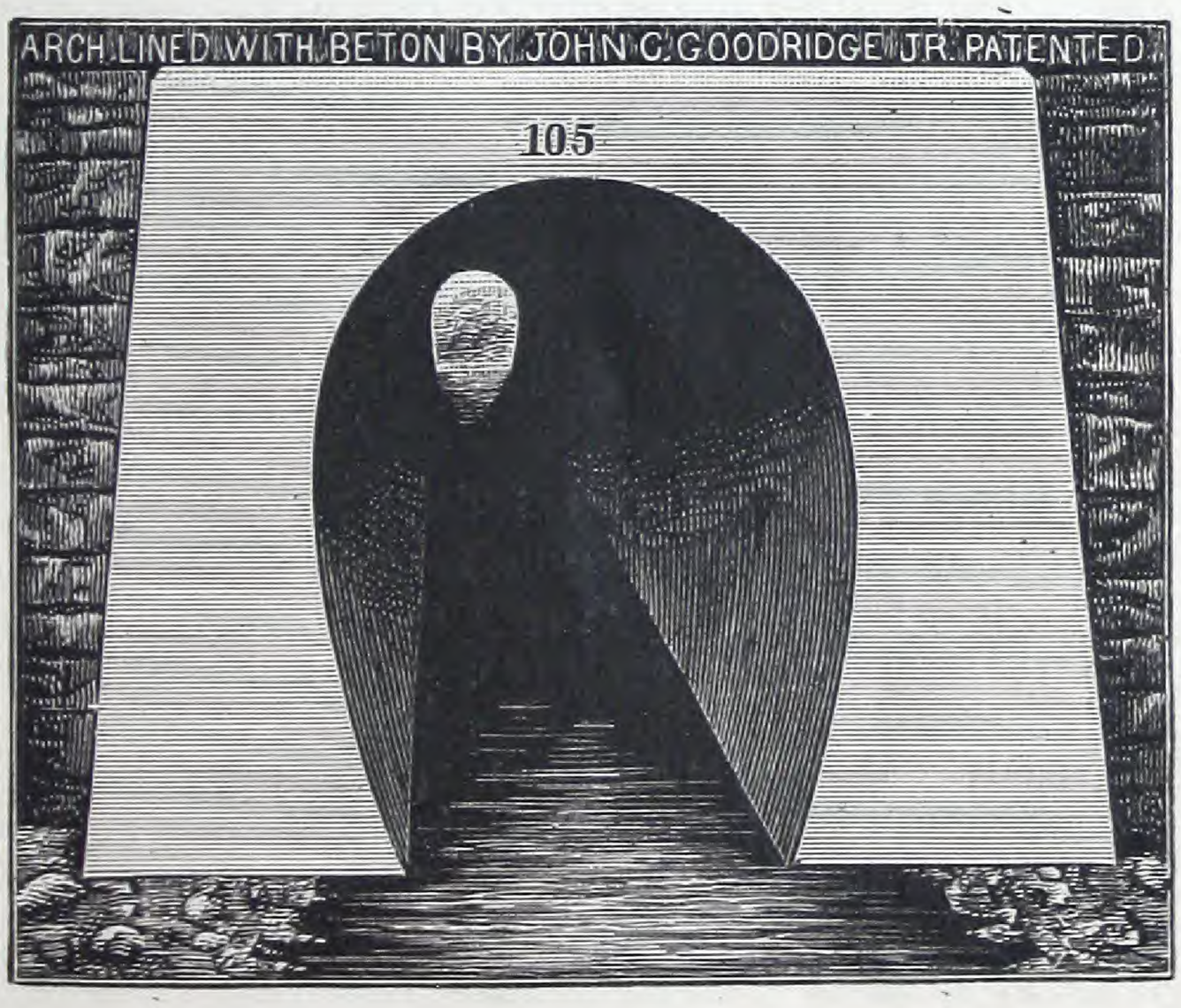
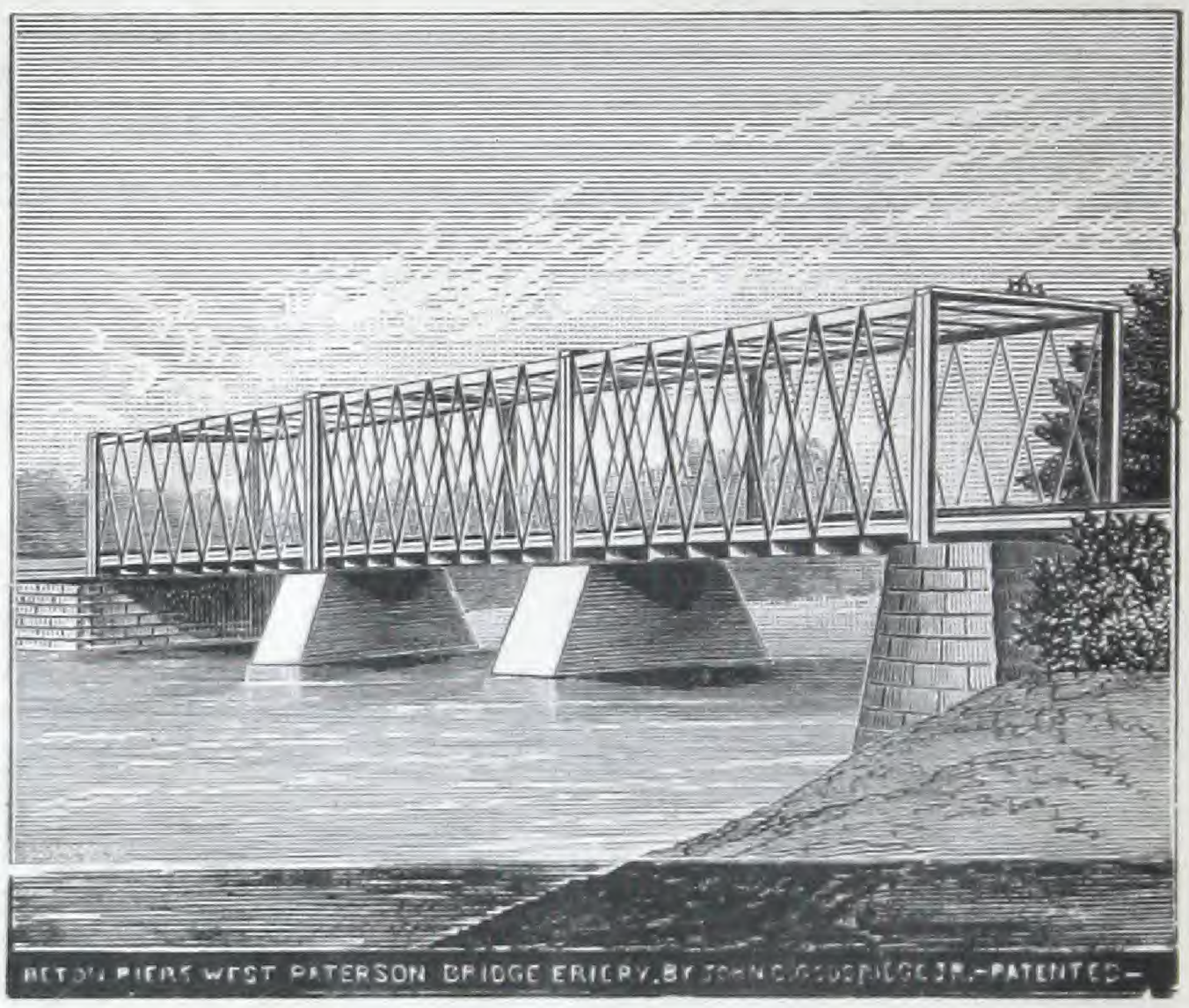


Fig. 11. Culvert 105. Repaired.

In the spring of 1880, the two piers under the double track iron bridge over the Passaic River, at West Paterson, were reported as cracking open and falling asunder. They were founded upon cribs, resting on the sandy bottom of the river, and the settling of the cribs, together with the jarring of the trains, was shaking the piers to pieces. It would have cost $12,000, and have involved some risk, to have rebuilt them under the bridge. After careful consideration and discussion, it was decided to envelop them entirely in a shell of beton from 4 to 12 inches thick. For this purpose wooden frames, planked inside, were erected at a suitable distance off, all around the pier, and the space between the planks and the stones was rammed full of beton. A coat 4 inches thick was also put on top, the whole enclosing six iron rods, three on a side, which had been temporarily put around the pier, to keep it from tumbling apart while its permanent repair was under discussion.

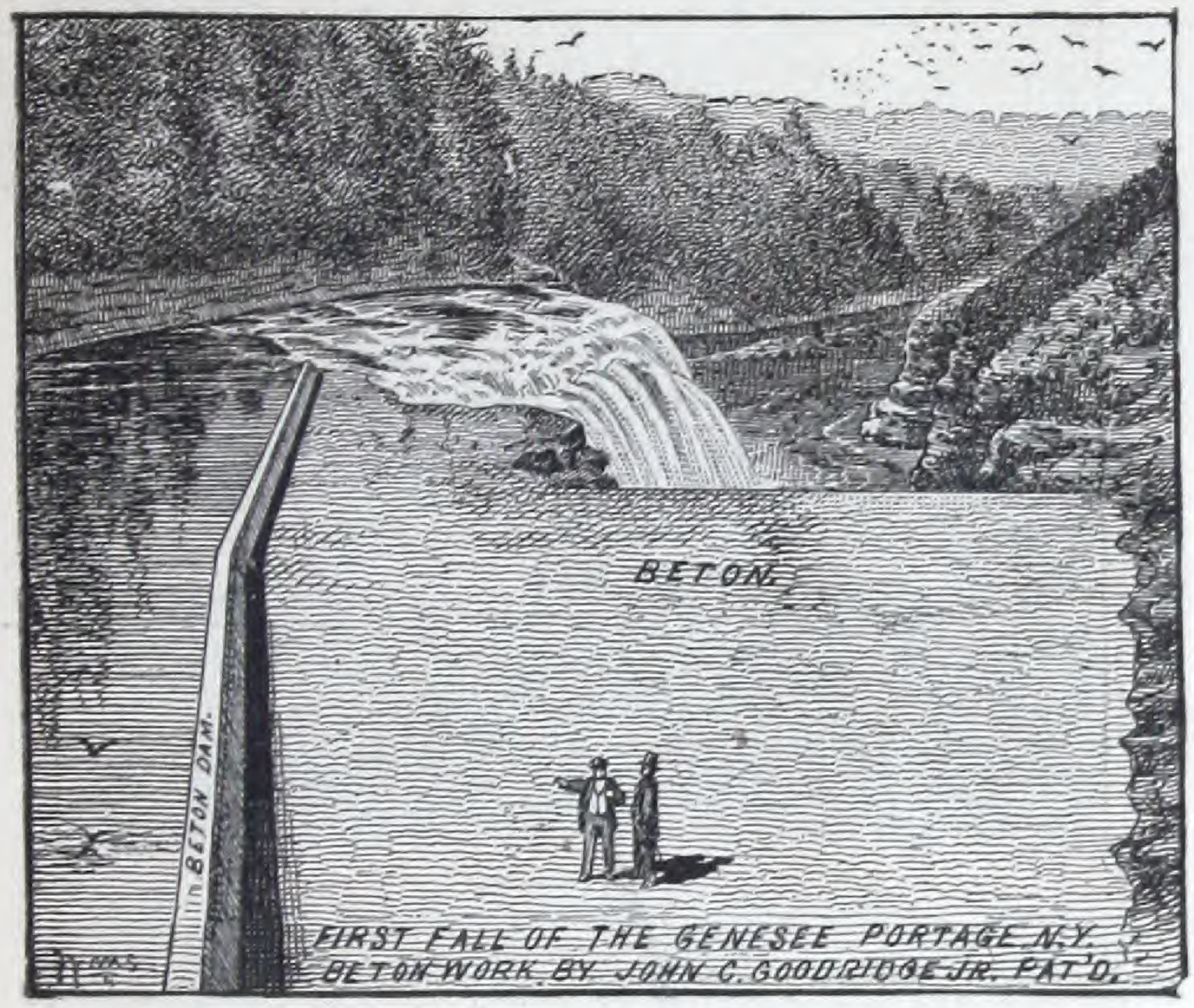


Fig, 12. West Paterson Bridge.

The cost has been $6,000, and it is confidently believed that the piers are now good for many years. The results have been entirely satisfactory. Large sums of money have been saved, not a single failure has occurred, and the repaired works seem likely to endure as long as if originally built of sound stone.

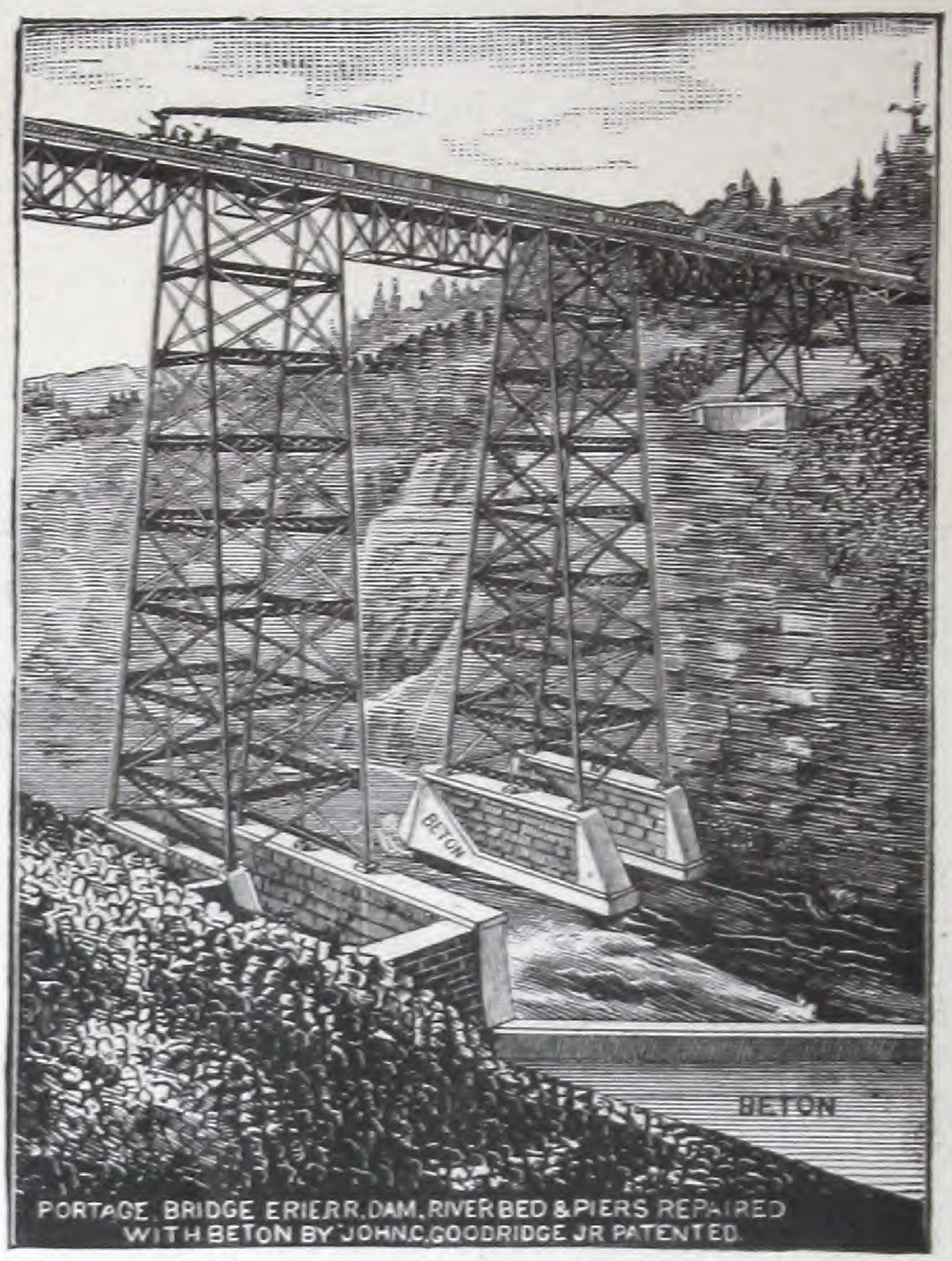
It is believed that the methods which have been described are capable of still further adaptation and extension. Existing structures, the rebuilding of which would seriously interfere with the continued use of a road, canal, or edifice, can be repaired with beton, as has been shown, without interference with the traffic, at a cost of from ten to twenty per cent. of the expense of a new work. This can also be done very rapidly, six thousand cubic feet of

beton, or over two hundred cubic yards, having, in some instances, been put in in a single day, so that engineers who may adopt this method of repairing masonry may be certain of saving both time and money.

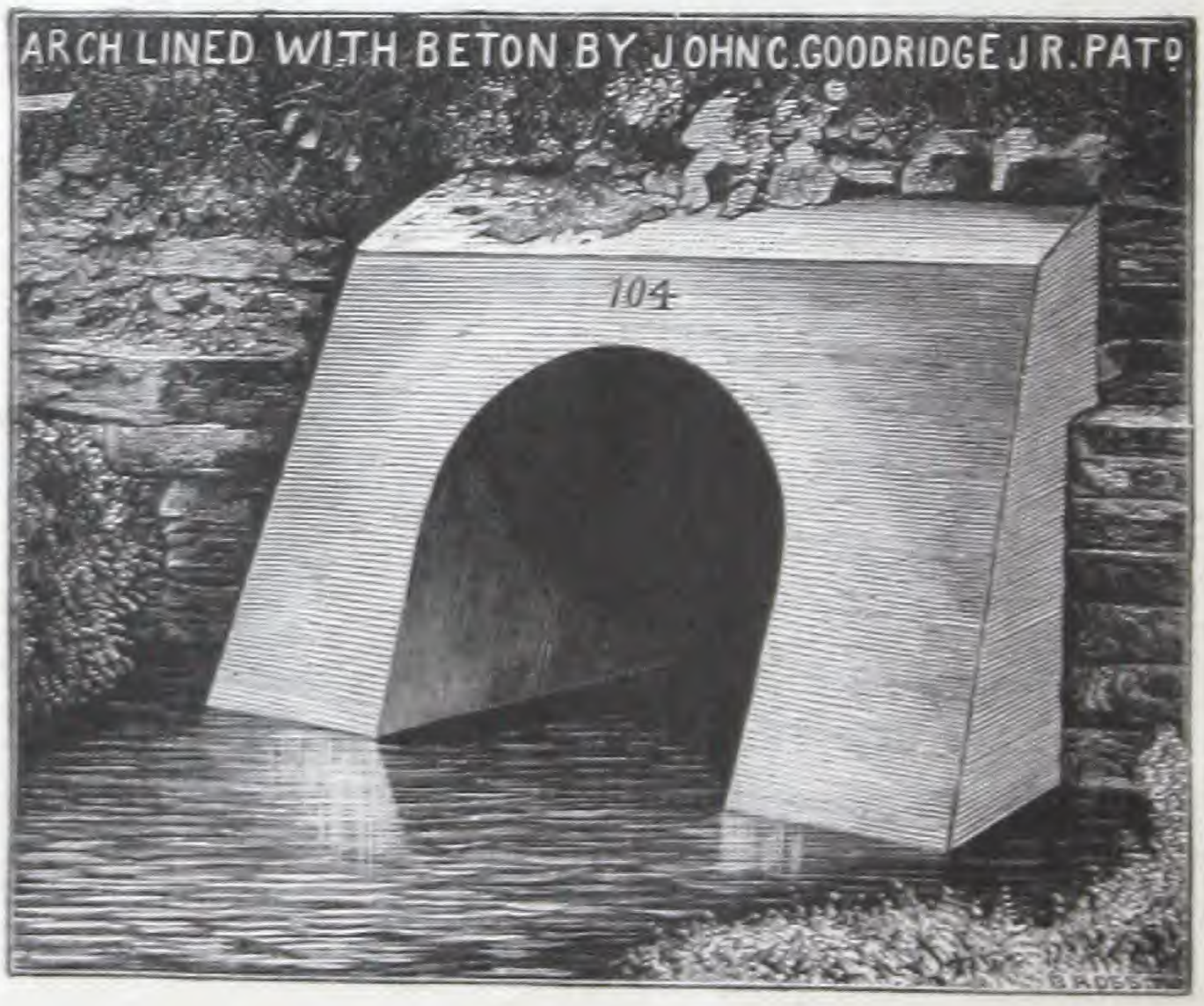


Beton Dam and River-bed filled with Beton, Portage, N. Y.
O. CHANUTE, C. E.

Since the foregoing paper was written by Mr. Chanute, considerable work has been done on the Erie Road by the same process. Among other work, the filling in of the first Fall of the Genesee River with beton, a cut of which is shown; an arch at Cuba, N. Y.; a bridge at Lanesboro', Pa.; two culverts at Blauveltville, besides other work, and with equally satisfactory results.

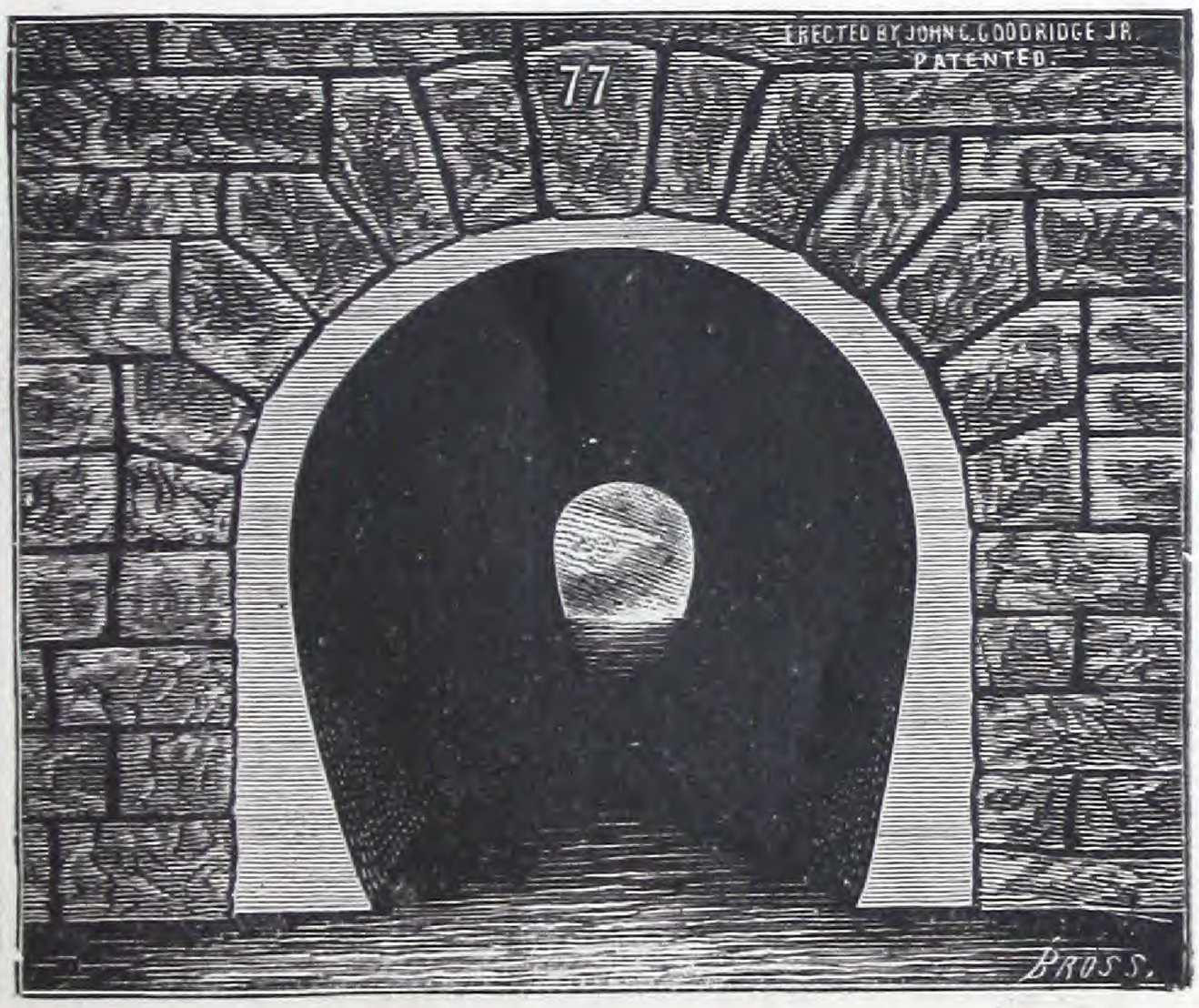


O. Chanute, C. E.



Erie Railway.

Erie Railway.



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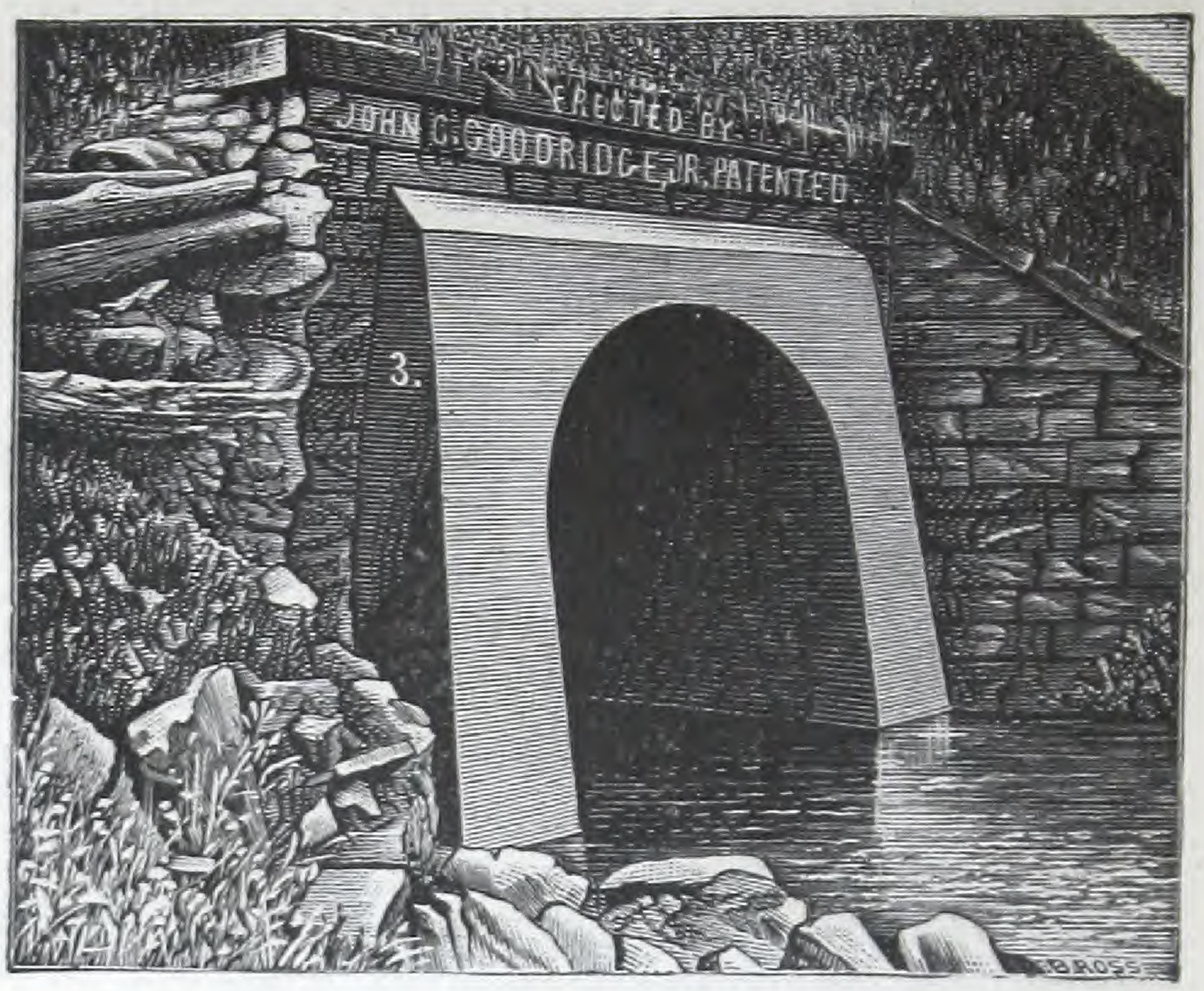

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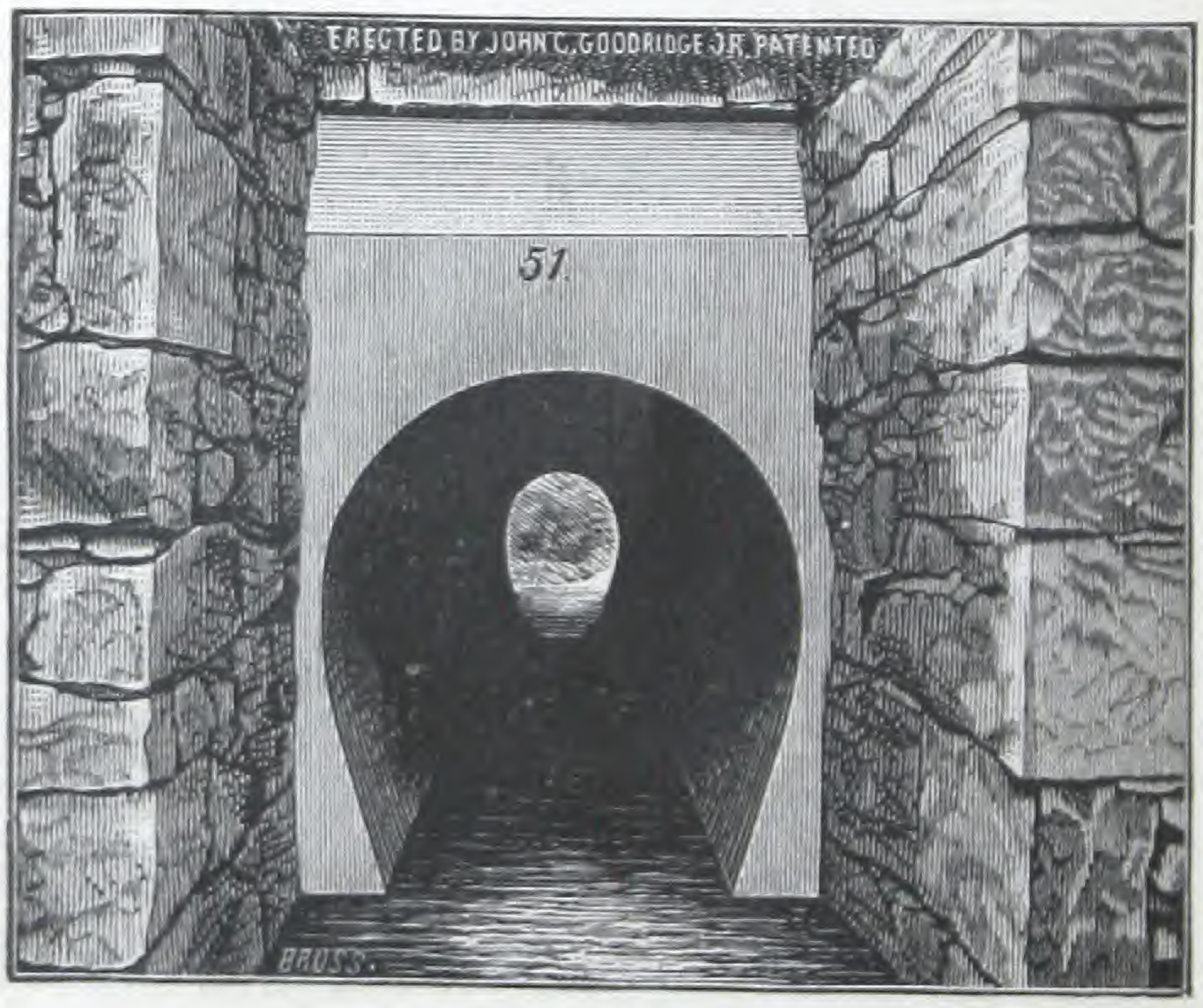
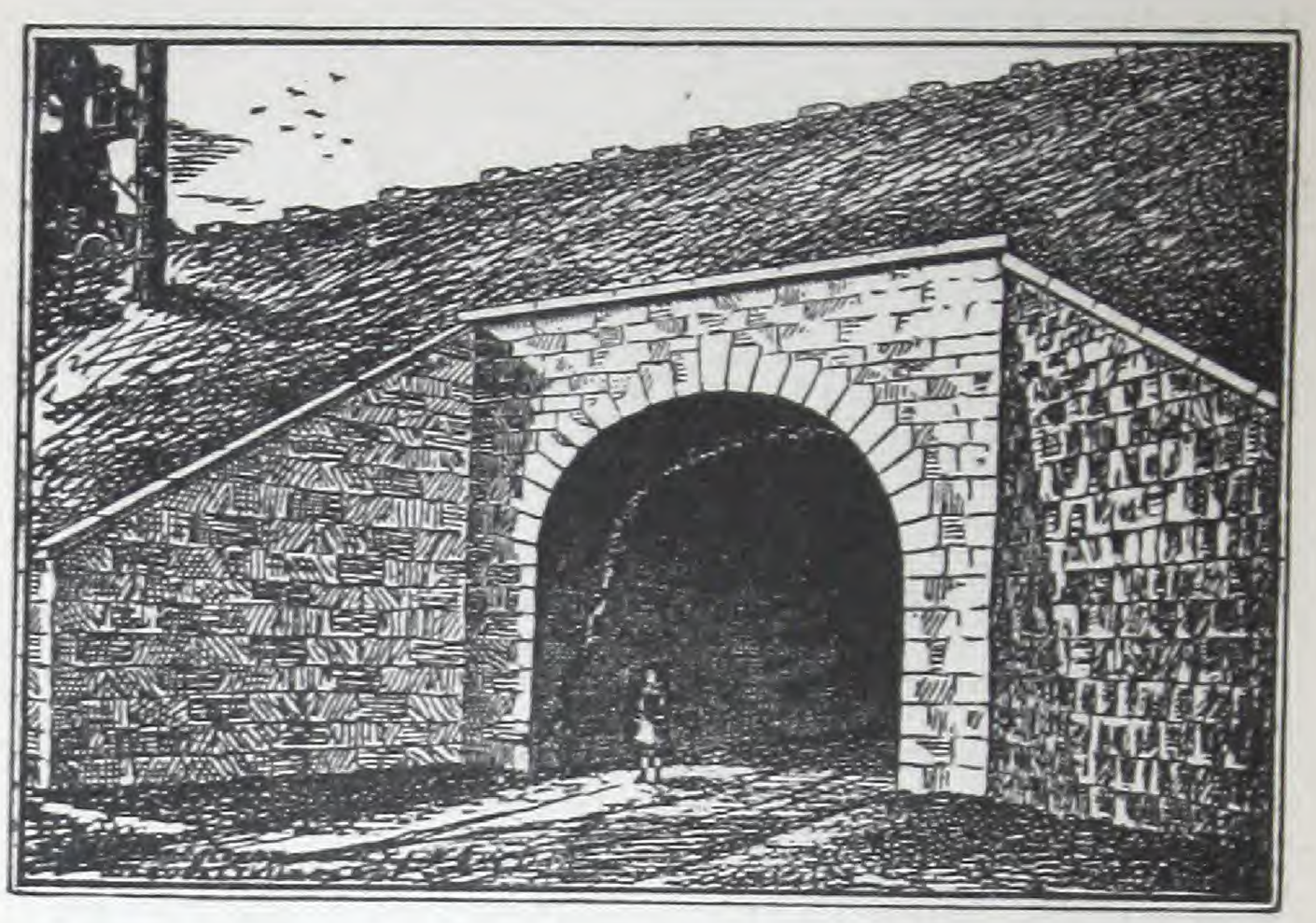


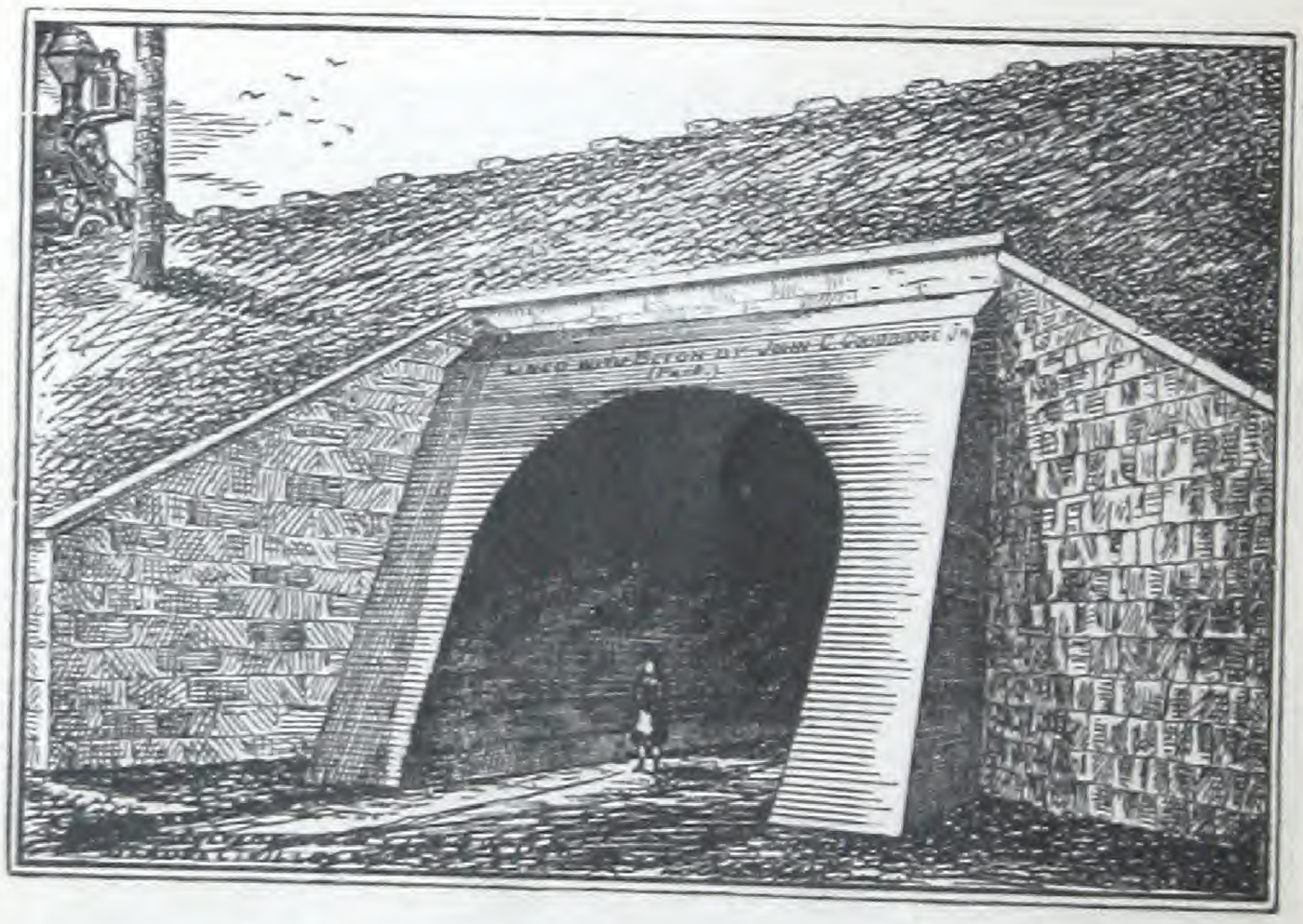
Erie Railway.

Erie Railway.

Culvert, Erie Railway.



Blauveltville Arch before Repair.



Bridge, Erie Railway, Blauveltville Arch.

The following are the claims of the

COIGNET AND GOODRIDGE PATENTS.

These patents are all the property of JOHN C. GOODRIDGE, JR., and all persons are cautioned against infringing on them. Infringements will be prosecuted.

UNITED STATES PATENT OFFICE.

JOHN C. GOODRIDGE, JR., of New York, N. Y.

Improvements in Methods of Repairing Structures with Beton or Concrete.

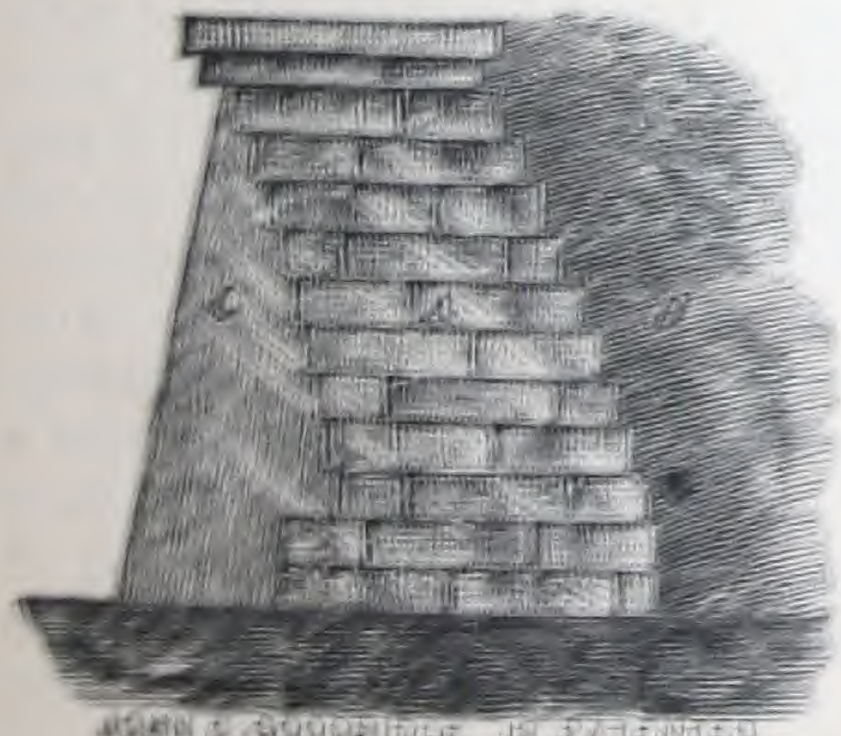
Specification forming part of Letters Patent No. **193,865,** dated August 7, 1877; application filed March 21, 1877.

To all whom it may concern:

Be it known that I, JOHN C. GOODRIDGE, Jr., of the City of New York, and State of New York, have invented a new and useful Method of Repairing Structures with Beton or Concrete; and I hereby declare that the following is a full and exact description thereof, reference being made to the plate which accompanies and forms a part of this specification.

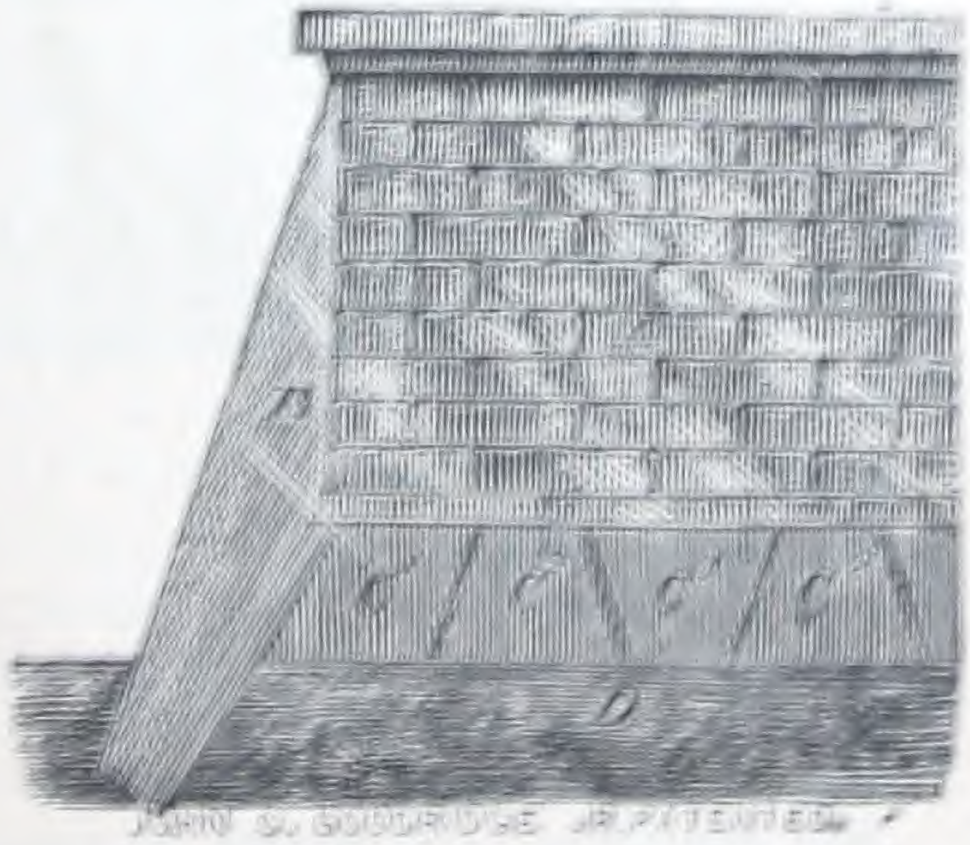
This invention relates to the repairing, strengthening, replacing, protection, and preservation of structures formed wholly or in part of stone, brick, metal, or of rock in its natural position, by the employment of Beton or Concrete. Repairs may become necessary from imperfect construction, disintegration, oxidation, friction, pressure, or concussion.

The material to which the Beton is to be applied should first be carefully cleaned, the joints thoroughly raked out, and all loose fragments removed. It should then be washed with a mixture of lime and water and a small quantity of cement. This assists the Beton in forming a bond. Care should be taken that no unslaked lime gets into the work. Moulds of wood or metal, or a wall of masonry, is then placed, and firmly fastened and braced, at a distance from the old structure or material decided upon as the proper thickness of the Beton. This mould is then filled with Beton, layer by layer, and thoroughly rammed and forced into all joints, crevices, irregularities, and inequalities of surface. This process is continued until the Beton is carried as high as necessary. After the Beton has set, which will be in from two to ten days, the moulds may be removed.



JOHN C. GOODRIDGE JR. PATENTED.

Fig. 1.



JOHN C. GOODRIDGE JR. PATENTED.

Fig. 3.

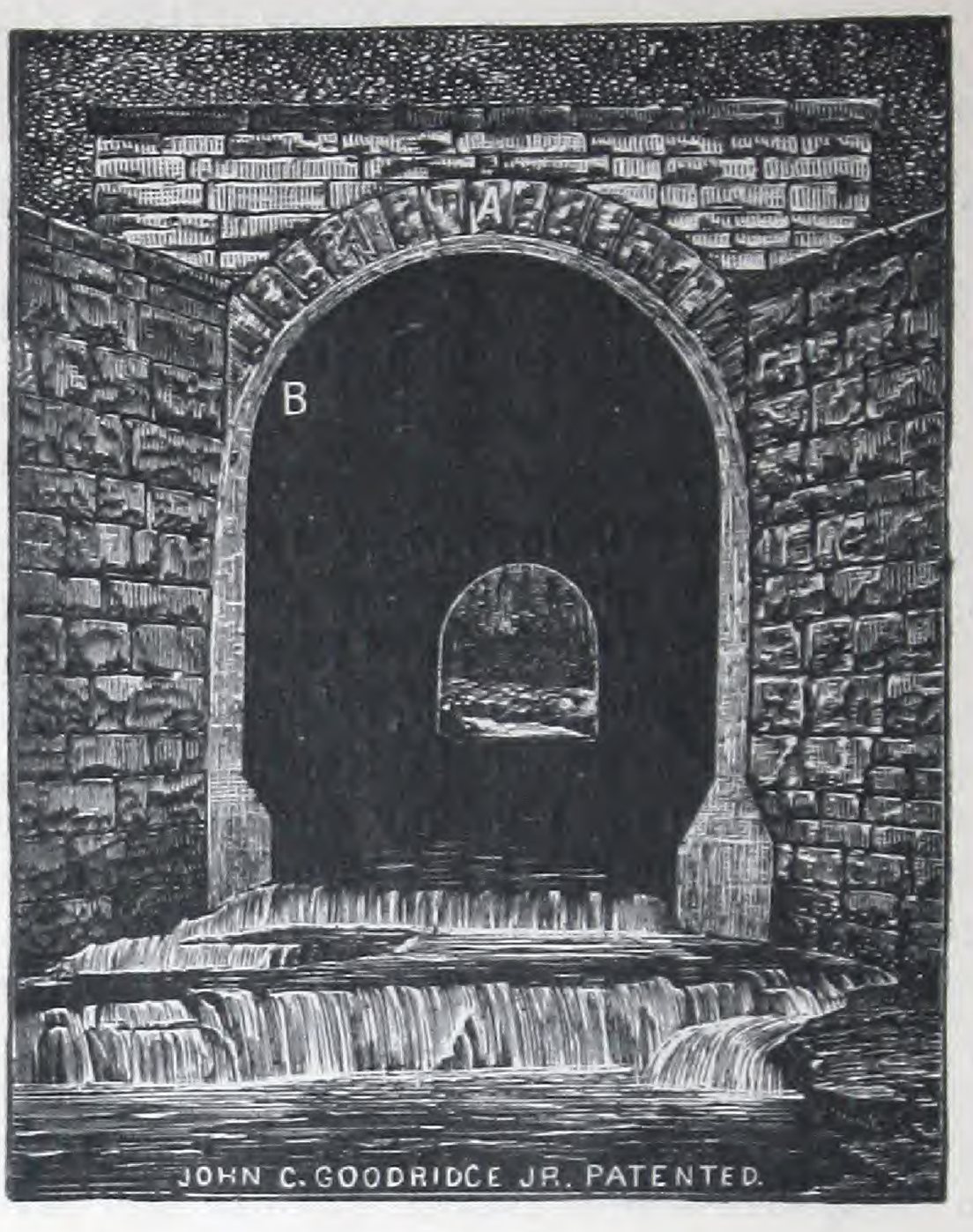


Fig. 2.

193,865.

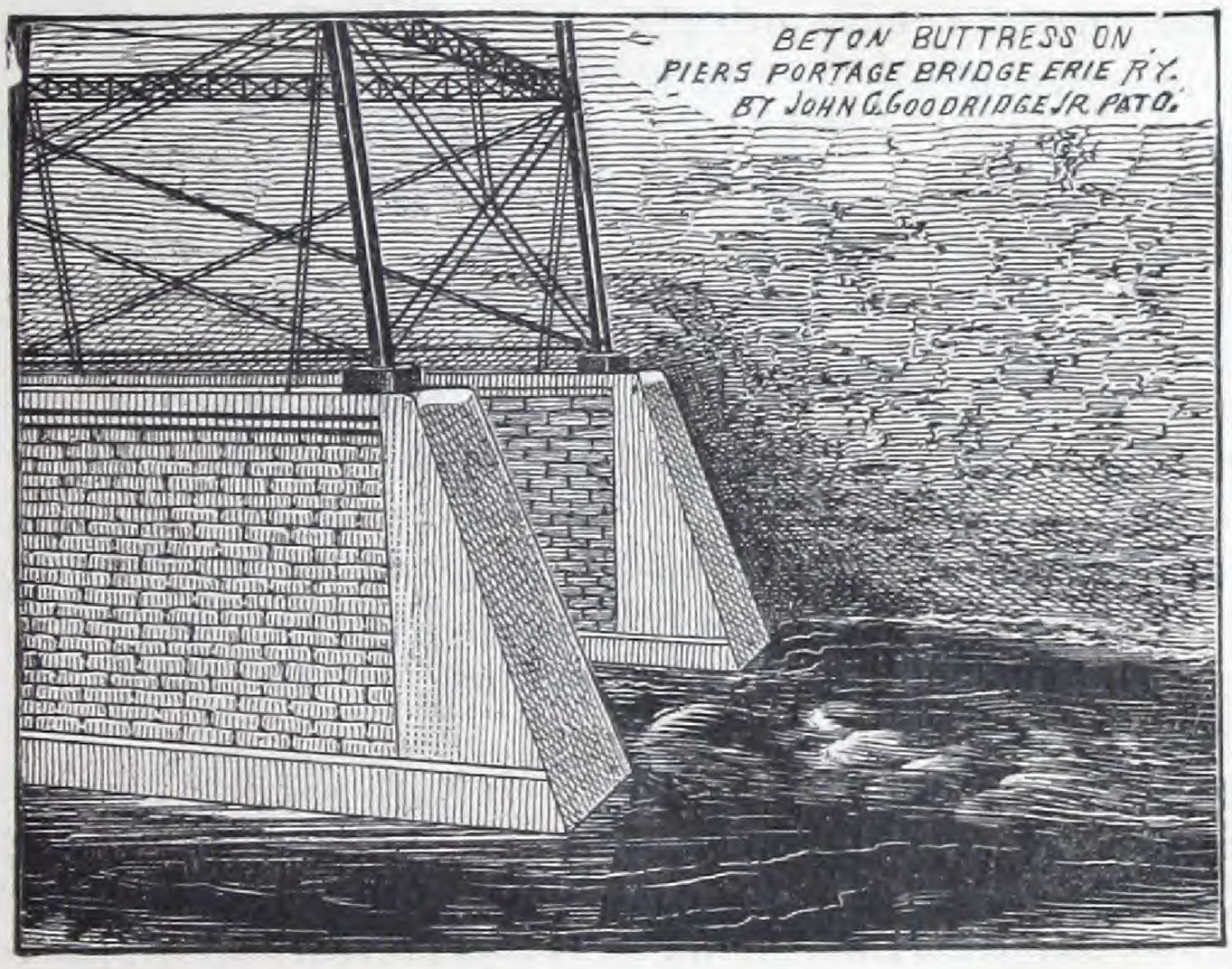
Fig. 1 shows a retaining wall, A, thrust out of alignment by the bank B. The Beton mass C is joined to the wall A in the manner described, and A and C form a wall which is stable, and capable of supporting the thrust of the bank. Fig. 2 shows an arch, A, strengthened by the Beton lining B. A mould is placed in the arch, and at a proper distance from it. The space between the arch and the mould is then carefully filled with Beton. This attaches itself to the arch and fills all joints and irregularities, so that water cannot get between it and the old structure. A new structure may be made by first placing a lining of Beton, and then placing the stone or other material upon that. When the top of an arch to be repaired is accessible it may be uncovered, all old filling removed, and the Beton placed upon the old structure, using it as a mould. Fig. 3 shows a method of replacing a foundation, A being the tower-wall or pier, C the foundation which is to be replaced, and D a firm soil or rock below, to which it is desirable to transfer the weight. Should the old foundation C be very uncertain, the buttress B should first be made of Beton. Section 1 of C is then removed, and replaced with Beton; next, section 3, and so alternately. Then return to 2 and 4; or they may be taken in regular order, if time is allowed between each replacement for the Beton to harden. In this manner any structure or its foundation may be replaced, section by section. The Beton, completely filling the space occupied by the material removed, prevents any settling, and allows

the structure to be used for the purposes for which it was constructed during the time occupied by its repair. If the surface of the structure is deteriorating, or not strong enough, from any cause, or if water, getting inside, separates its component parts, as happens particularly in river piers and abutments, it may be entirely encased in Beton, and its whole surface covered.

I do not claim as new the building of new structures entirely of Beton or Concrete, or the backing of new structures having a stone face, or of plastering of masonry by means of trowels and floats, as is done in mastic work.

What I claim and desire to secure by Letters Patent, is—

The within described method of repairing and replacing structures formed wholly or in part of stone, brick, or metal, or rock in its natural position, by the employment of Beton or Concrete, substantially in the manner set forth.



JOHN C. GOODRIDGE, JR., of New York, N. Y.

Improvement in Manufacture of Beton.

Specification forming part of Letters Patent No. **194,085,** dated August 14, 1877; application filed June 5, 1877.

To all whom it may concern :

Be it known that I, JOHN C. GOODRIDGE, JR., of the city of New York, in the county of New York and State of New York, have invented a new and useful Improvement in Manufacture of Beton, of which the following is a specification

The nature of this invention consists in a special mode of preparing cement and mixing it with sand and a specified quantity of water, and their manipulation in such manner as to make a beton or concrete which shall be more uniform in composition and stronger than any heretofore made, and without the unsightly and injurious checks and efflorescence which appear in all previous combinations of sand and cement.

In the method now employed of making beton or concrete, cement and sand are used without previously preparing the cement. In the Coignet methods sufficient water only is added to make a plastic pulverulent paste. This does not contain sufficient water to form hydrates, unless lime enters largely into the composition, in which case the moisture held by the lime is taken up by the cement during its crystallization, the lime absorbing its moisture from the air ; but lime in a large quantity weakens the beton, from having but a low adhesive power in comparison with cement. Neither is it able to withstand the action of water or fit for underground work, as it does not become hard when kept constantly damp, nor does it become hard in the interior of large monoliths when it is removed from the effects caused by the atmosphere.

In the other and ordinary methods a larger quantity of water is used, sufficient to make a semi-liquid mass that will flow. This excess of water is forced out of the concrete by the contraction of the cement during its crystallization, and leaves the stone porous. It also prevents the proper ramming of the beton, and gives rise to the difficulty known as "*laitance*" hereinafter described. On the other hand, a beton containing too little water becomes friable.

My process is as follows: When in the construction of large monoliths or structures, largely underground, the checks and efflorescence which usually appear are not a serious objection. Sand and cement may be mixed in the proportion of from three to six parts of sand to one of cement. This may be done by means of machinery or by hoes, shovels, and rakes. During this process water is added by means of a hose or watering-pot having a rose jet.

The water is added gradually until the sand and cement contains so much that a handful of the beton will, if tightly squeezed, allow a little water to exude, but will, when laid down, still retain the impression of the hand. The beton so mixed will have about the consistence of melting snow. It can be compacted in the same way, and pressure will force the moisture out of it. This condition, though difficult to describe, is learned at sight by the workmen, and the correct amount of water is more accurately gauged by trying the beton from time to time in the hand during its mixture (as it varies in different cements) than can be done by any rule of measurement. The beton is then placed in position and rammed, as described below.

The quantity of water thus gauged will be enough to form hydrates, in combination with the components of the cement, leaving no excess to be forced out during crystallization, and does not prevent the proper ramming of the beton, while there is not sufficient to cause *laitance*. But to obtain a perfect result where a finished surface is requisite, and to make a beton free from the deleterious ingredients that are found in all cements, and to insure the use of a proper quantity of water, I proceed as follows: Having obtained the heaviest slow-setting cement, the first step in this process is to separate from it the light, earthy impurities—the uncombined lime and clay and the soluble salts. This can be done to a considerable extent by a regulated current of air being driven against the cement while falling from a height, and in a proper enclosure; or it can be done by revolving screens, or by means of a centrifugal mill; and I claim these methods to be equivalents of the following. But the method which I prefer, and recommend as much more perfect, is to allow the cement to fall slowly into a box filled and constantly fed by a stream of water, the entrance of which is preferably near the bottom of the box. One side of the box is lower than the others, for the overflow of the water. Where a constant stream of water cannot be had, the result may be obtained by agitating the cement with water in a swinging box or other convenient way, pouring off the water, and supplying its place with fresh water from time to time.

A box may be placed in and on the bottom of the larger box to collect the cement as it settles. The portion thus preserved consists of the heavy, gritty and inactive parts of the cement, which is without adhesive power, and which acts simply as so much sand. This equals about ten per cent. of the whole mass of cement.

Cements containing a larger amount than usual of this gritty portion may, when mixed pure, stand a high test, but will not bear a large admixture of sand. With this gritty part settles the true cement, which we call the "matrix." This is that portion which is capable of crystallization or hydrosilicatization, called "setting." This portion of the cement is the only one of value, and is about eighty per cent. of it.

The third or lighter portion, which is washed away with the overflowing water, consists of impurities, light earthy matter, uncombined lime and clay, and soluble salts. This portion of the cement is entirely without adhesive power, and, when separated from the other portions of the cement acts in all respects like the impure and dirty clays. When dry it shrivels and con-

tracts, and when wet expands and becomes slippery. This portion of the cement is the cause of the unsightly checks, and what appear to be cracks but which are simply projections of this earthy portion, which, by its own action in contracting and expanding, and the crystallization of the cement, has become separated from it. With this earthy portion the alkaline salts, consisting mainly of soda and potash, escape. This is the portion that causes the efflorescence or white appearance on the stone as heretofore made, and also what is known as *laitance* on concrete laid in water.

The light, earthy, and soluble portions having been removed from the cement, the supply of water is turned off, and it is all allowed to escape from the wash box

The cement, freed from its deleterious portions, and being thus saturated or supplied with the proper amount of water, is thoroughly mixed by machinery, or by means of shovels, hoes, or rakes, with clean, dry, sharp sand, in the proportions of from three to six parts of sand to one of cement, according to the strength desired.

The beton thus mixed is rammed into position, layer by layer, with a pounder, having knobs or projections to make an irregular face. The irregularities made by the pounder on the top of the layer leaves it rough, for the better bonding of the succeeding layers.

During the process of ramming or compacting, large stones of suitable shape to form a good bond may be put into the mould or mass, and the beton rammed around and between them, the stones not being allowed to come in direct contact with each other. This gives stronger work and allows more thorough ramming and the use of larger stones than where, in the usual way, broken stone is mixed with the sand and cement before being put into the mould or mass.

The phenomenon of *laitance* is one of the gravest difficulties besetting the laying of concrete under water. It is caused by the impurities hereinbefore set forth. When the concrete is mixed in the ordinary manner, so as to form a semi-liquid mass, these impurities rise to the top of the layer in position, gradually subside, and deposit an unctuous stratum. Thus between each new layer of the concrete is interposed a slippery layer, utterly preventing any union or bond between the layers of concrete, and very seriously impairing the solidity and strength of the structure. The former of my processes prevents this, since the beton is sufficiently dry to prohibit any movement of its component parts. The second modification of the process prevents it for the same reason, and because the impurities forming the *laitance* are themselves eliminated.

I do not claim as new the mixing of sand and cement with sufficient water to form a pulverulent pasty powder, nor a mixture of sand and cement and water sufficient to form a semi-liquid mass, as in ordinary concretes.

Having thus described and limited my invention, what I do claim is:

1. As a new manufacture, a beton formed of sand and cement, mixed with water to the point of saturation, substantially as hereinbefore set forth.

2. The process of purifying cement by separating therefrom the impure, light, and earthy matters, the uncombined lime and clay, and the soluble salts, substantially as hereinbefore set forth.

3. As a new manufacture, a beton composed of sand and cement purified, as hereinbefore set forth, mixed with water to the point of saturation.

4. As a new manufacture, the stone or monolithic masonry made from the substances and treated in the manner described.

In testimony that I claim the foregoing improvement in manufacture of beton, as above described, I have hereunto set my hand.

Construction and Repair of Tunnels, Culverts, Etc.

No. **262,402.** Patented August 8, 1882.

Having now described my invention, what I claim as new, and desire to patent, is:

The monolithic structure or buttress, *C*, herein described, formed by casting in proper layers in a previously made mould built against the wall to be supported, and around and against the mouth of the culvert, beton or concrete, and then removing the mould as soon as the beton has set, as set forth.

In testimony that I claim the foregoing improvement in construction and repair of tunnels, culverts, and the like, as above described, I have hereunto set my hand this 11th day of February, 1882.

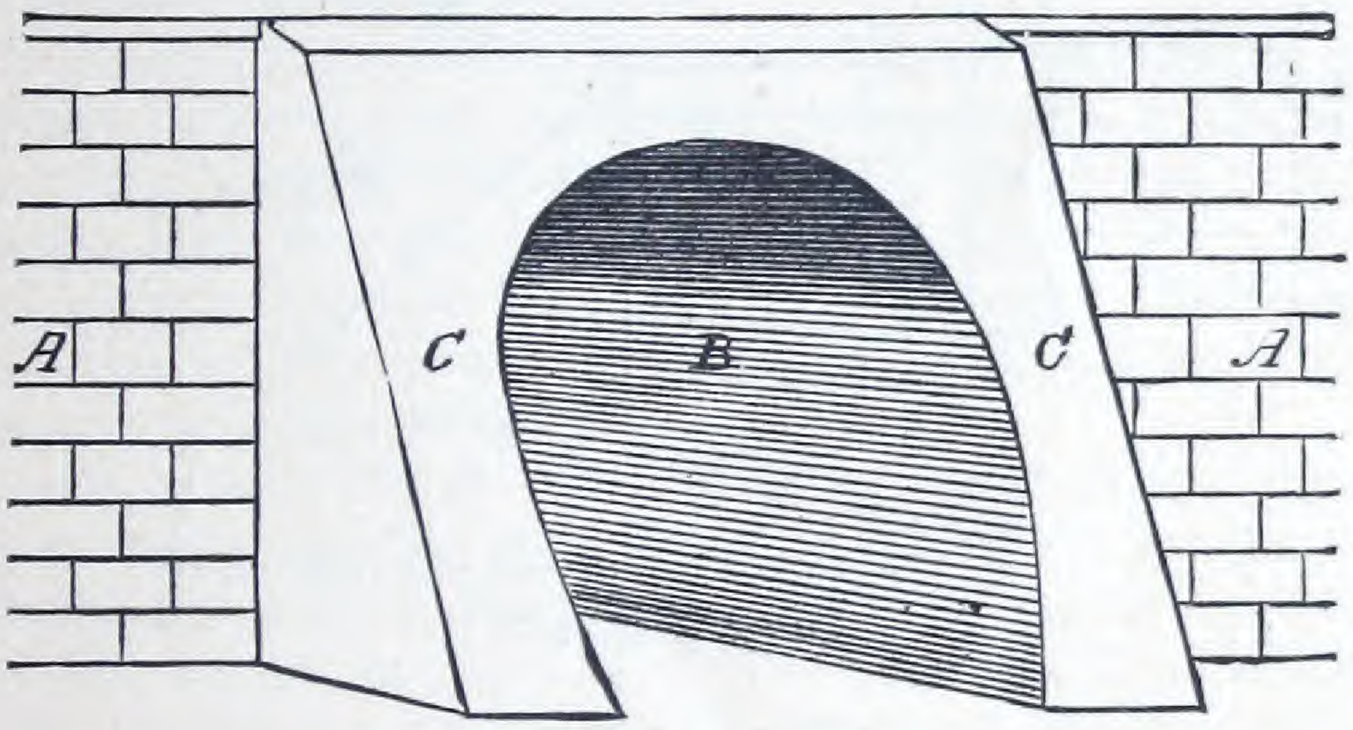


Fig. 1.

Patent No. 262,402.

Method of Repairing Structures with Beton or Concrete.

No. **271,234.** Patented.

1. The process herein described of repairing, undermining, and protecting different structures and their foundations, consisting of forming trenches parallel to the sides on which it is desired to operate, and building therein a

wall and then running trenches from said wall to and under the foundation, of the structure as far as may be desired, and filling the same with concrete or beton, which will set therein in such a manner as to form, when the process is complete, a monolithic foundation, substantially as described.

2. The process of repairing and protecting structures, consisting in first building a circumscribing wall of beton in a previously dug trench situated a a suitable distance from the sides of the structure, then building a buttres between such wall and the structure, in order to protect the structure while the other repairs are being accomplished, as set forth.

3. The within described method of increasing the bulk and weight of structures composed wholly or in part of beton, concrete, or like materials and economizing in the use of the same, by embedding therein hollow forms filled with broken stone, earth, or other heavy and cheap material.

Fig 2.

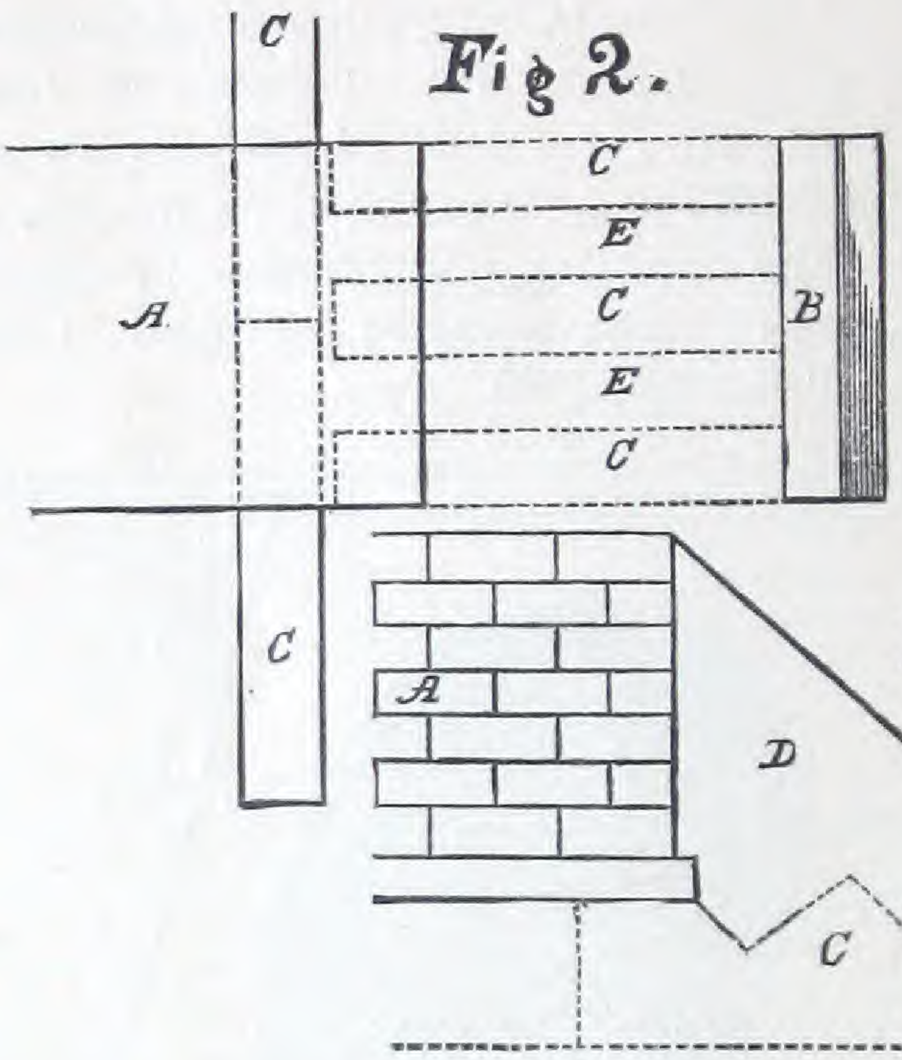


Fig 1.

Patent No. 271,234.

Improvement in Methods of Laying Concrete under Water.

Specification forming part of Letters Patent No. **188,123,** dated March 6, 1877; application filed January 29, 1877.

To all whom it may concern :

Be it known that I, JOHN C. GOODRIDGE, JR., of the city of New York, county of New York, State of New York, have invented a new and useful improvement in the Method of Laying Concrete under Water; and I hereby declare that the following is a full and exact description thereof, which will enable others skilled in the art to do the same.

In the ordinary method employed in laying concrete under water, it has been considered necessary to use broken stone and coarse gravel with cement. This material thus mixed has been thrown directly on the water, which was enclosed to prevent washing away the cement, or has been dumped from boxes prepared for the purpose.

I have found, by repeated experiment, that it is impossible to obtain a good result from such a mixture. The varying velocity with which bodies fall through water is owing to their different specific gravities. If stone of a specific gravity of 2·5 are used with a cement of 1·4, the stone is in its descen- washed entirely free from the cement, and is deposited on the bottom, while the cement, held in partial suspension, and moved by every new addition of the mixture, is finally deposited above the stone and gravel, after being rendered inert by the washing of the water.

My improvement consists, first, in rendering the water (which is enclosed in water-tight compartments or coffer-dams, to prevent any motion or current that may allow the escape of the concrete) strongly alkaline by the addition of a sufficient quantity of air-slaked lime. This renders the water less apt to hold the cement in suspension, and causes a more immediate precipita- tion of the cement. It also causes the concrete to attach itself the more firmly to adjoining masonry; second, sand, clean, sharp, and of fine grain, is selected, and as near as possible of the same specific gravity as the cement, which is about 1·4, and weighing about eighty-eight pounds to the cubic foot, and carefully mixed with cement.

A good proportion for general use is three parts of sand to one of cement, the proportion may be varied, depending on the strength of the cement. In this proportion it requires 4·25 cubic feet of dry cement and 12·75 cubic feet of dry sand to make 10 cubic feet of concrete, measured after being laid in place. The sand and cement are then mixed with water. Sufficient is added to make it thinner than is used in the plastic betons, yet not watery or this enough to run, as used in ordinary concrete.

A quantity of this mixture should then be placed on an incline, where it should be allowed to lie for a short time until the cement has formed a slight bond with the sand—five or ten minutes—varying with the quickness of the setting of the cement, and then the whole mass should be allowed to slide slowly down the incline or inclines, the bottom of which should be placed in the water, and the concrete evenly distributed by any suitable means.

A large mass should be collected before depositing, in which case the greater portion of the concrete does not come in contact with the water. Succeeding batches are prepared and deposited in the same way, and the process is continued until the space to be occupied by concrete is entirely filled.

Beton so deposited under water needs no ramming. The grains of sand close together, with their irregular interstitial spaces filled with concrete.

We have then a homogeneous, compact mass, weighing about one hundred and forty-four pounds to the cubic foot, and a specific gravity of about 2·3, and capable of having a crushing strain of over six thousand pounds per square inch, and a tensile strength of over three hundred pounds per square inch.

Having thus described my invention, what I claim is :

The method of laying concrete under water, as herein described, consisting in rendering the water strongly alkaline by air-slaked lime, and depositing into said water a mixture of sand and cement by means of an incline, substantially as and for the purpose set forth.

JOHN C. GOODRIDGE, JR., of New York, N. Y.

Method of Repairing with Beton or Concrete.

Patent No. **317,337,** dated May 5, 1885.

I do not claim in this application the herein described "process" of lining and repairing with beton and concrete, for the reason that I have made the said process the subject of a separate application for Letters Patent, which was filed on or about the 4th of February, 1883, Serial No. 154,948.

Having thus described my invention, what I claim as new, and desire to patent, is:

1. The within-described lining or casing for tunnels, shafts, piers, and abutments, which consists of the frame of the required shape placed a suitable distance from the structure to be strengthened, and the concrete or beton so applied as to embed the said frame therein, substantially as set forth.

2. The herein-described lining or casing for tunnels, shafts, piers, abutments, etc., which consists of a frame of the required shape placed a suitable distance from the structure to be encased, beton or concrete so applied as to embed said frame therein, and sand, broken stone, or other cheap material filled in between the beton or concrete and the surface encased thereby, substantially as set forth.

3. In a lining or casing substantially as herein described, the combination, with the frame forming an integral part thereof, of screw-bolts projecting from said frame and provided with thimbles, bearing-plates, and screw-nuts, the whole so arranged as to removably secure moulding boards to said frame and at the required distance therefrom, as and for the purpose set forth.

In testimony that I claim the foregoing improvement in the method of repairing or building with beton or concrete, as above described, I have hereunto set my hand this 21st day of August, 1884.

(No Model.) 2 Sheets—Sheet 1.

J. C. GOODRIDGE, Jr.

METHOD OF REPAIRING WITH BETON OR CONCRETE.

No. 317,337. Patented May 5, 1885.

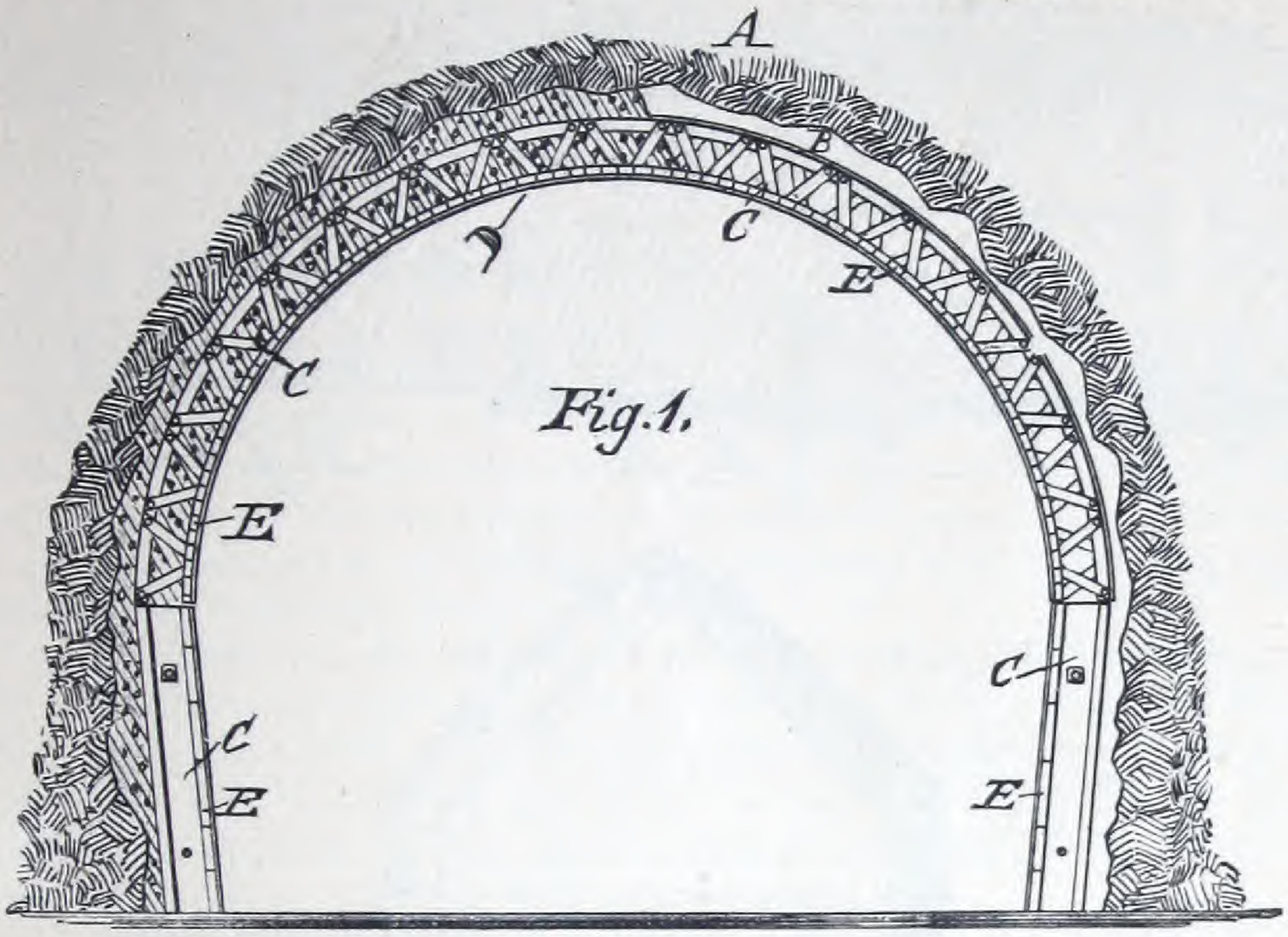


Fig. 1.

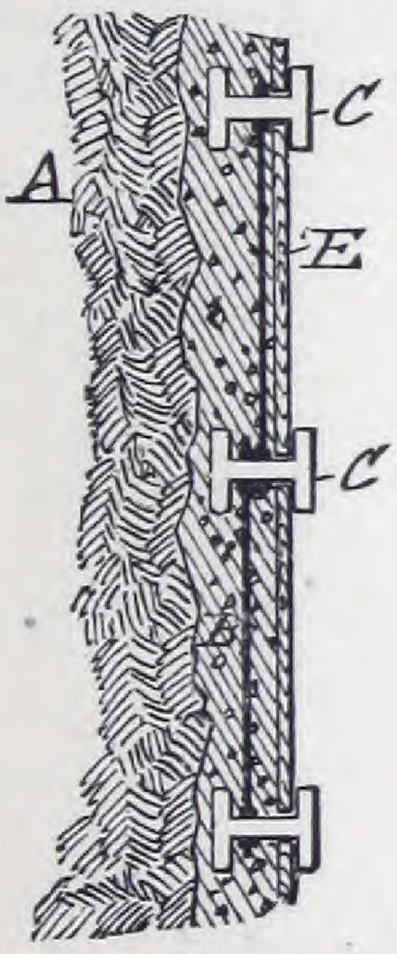


Fig. 2.

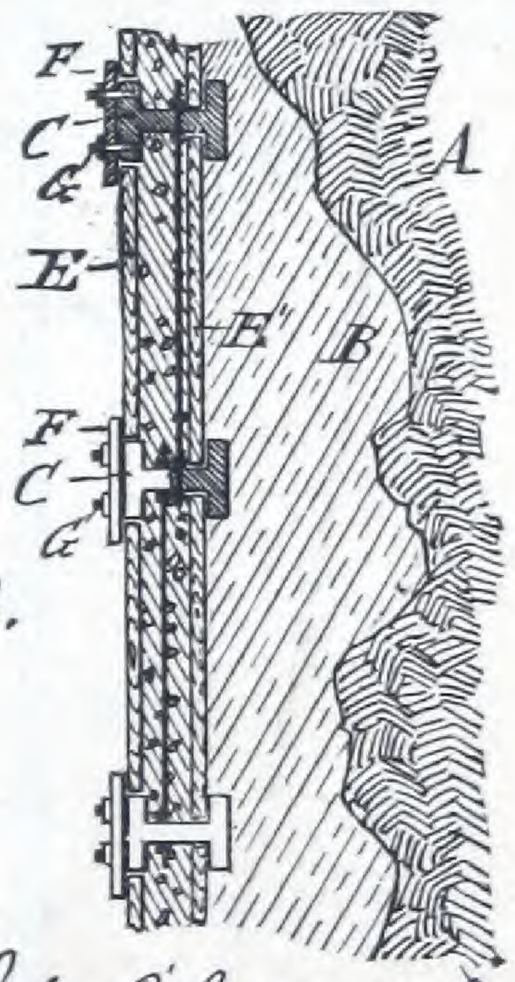


Fig. 3.

John C. Goodridge Jr.
INVENTOR

WITNESSES:
Henry R. Wells
Wm. T. Lowe

BY
Henry R. Wells his
ATTORNEY

(No Model.) 2 Sheets—Sheet 2.

J. C. GOODRIDGE, Jr.

METHOD OF REPAIRING WITH BETON OR CONCRETE.

No. 317,337. Patented May 5, 1885.

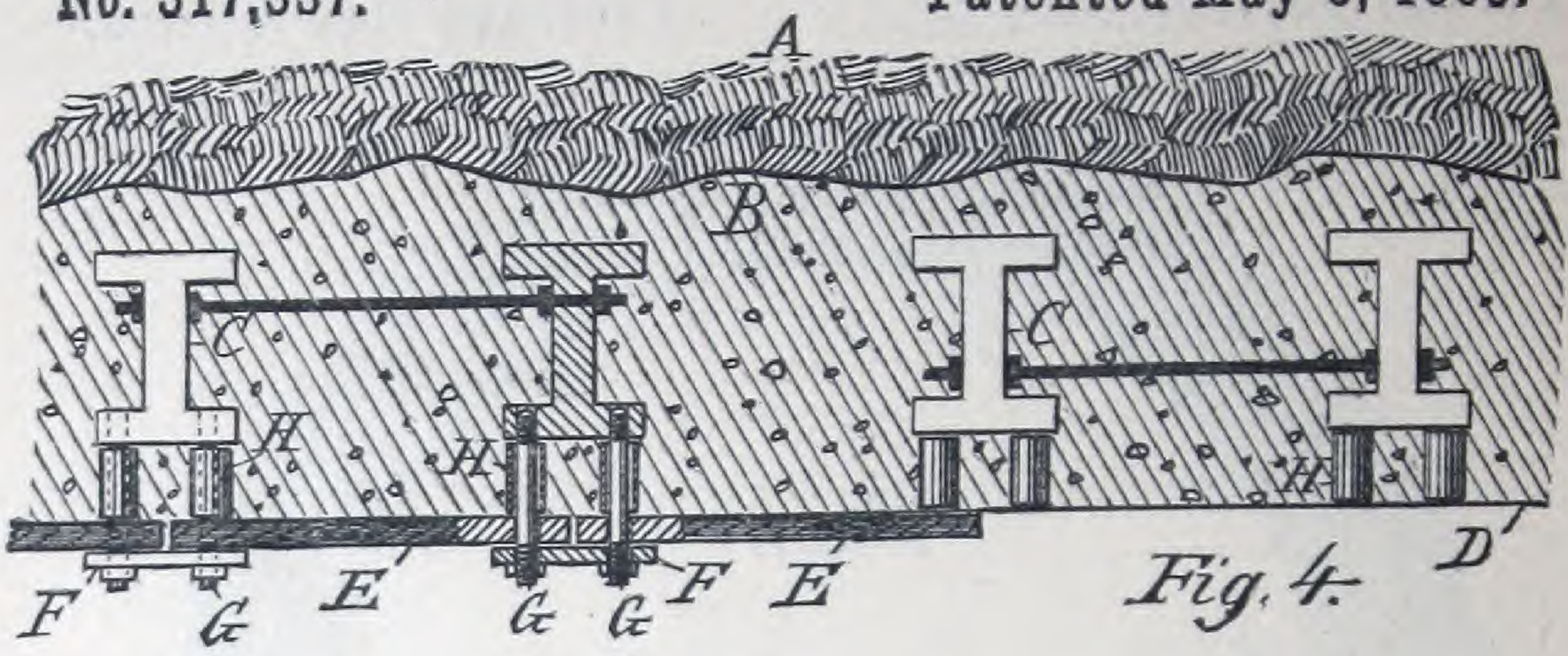


Fig. 4.

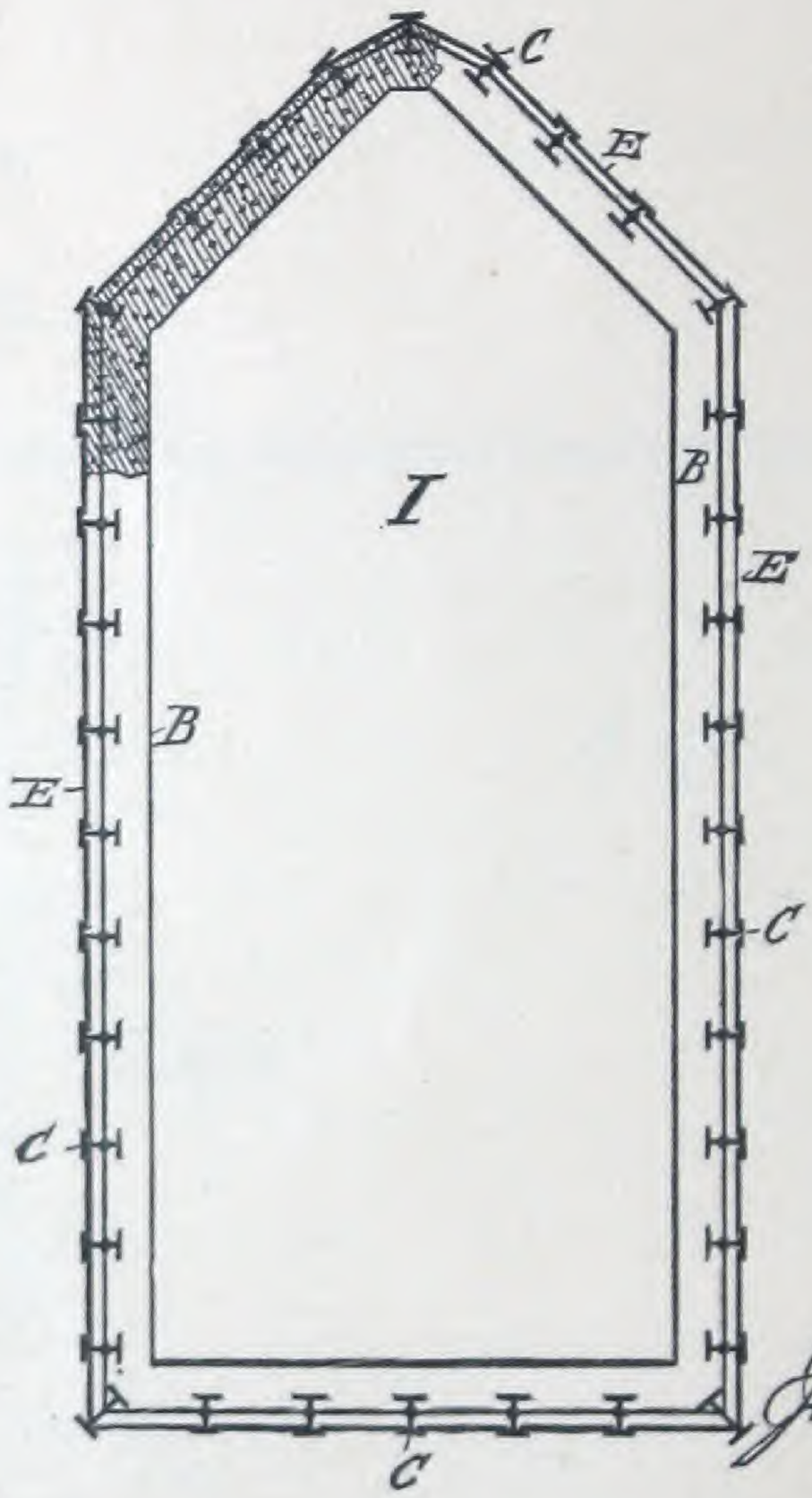


Fig. 5.

WITNESSES:
Henry P. Wells
Wm. A. Lowe

John C. Goodridge Jr.
INVENTOR

BY
Henry P. Wells Jr.
ATTORNEY

JOHN C. GOODRIDGE, JR., of New York, N. Y.

Process of Construction and Repair with Beton or Concrete.

Specification forming part of Letters Patent No. **317,338,** dated May 5, 1885.

Application filed February 4, 1885. (No model.)

Having thus described my invention, what I claim as new, and desire to patent, is:

1. The process of repairing, lining, or encasing tunnels, shafts, piers, abutments, or other structures, which consists in, first, constructing a frame of the required shape, a suitable distance from the structure to be strengthened; next, securing the moulding boards to said frame and then filling in the beton or concrete behind said moulding boards, embedding their supporting frame, substantially in the manner set forth.

2. The within described process of lining or encasing tunnels, shafts, and like structures with beton or concrete, consisting of erecting a suitable frame-work, attaching a double layer of lagging thereto, filling between said lagging and around said frame-work with beton or concrete, and filling the space between the lagging and the natural rock or the body to be re-enforced with sand, broken stones, or other cheap material.

In testimony that I claim the foregoing improvement in processes of construction and repair with beton or concrete, as above described, I have hereunto set my hand this 14th day of January, 1885.

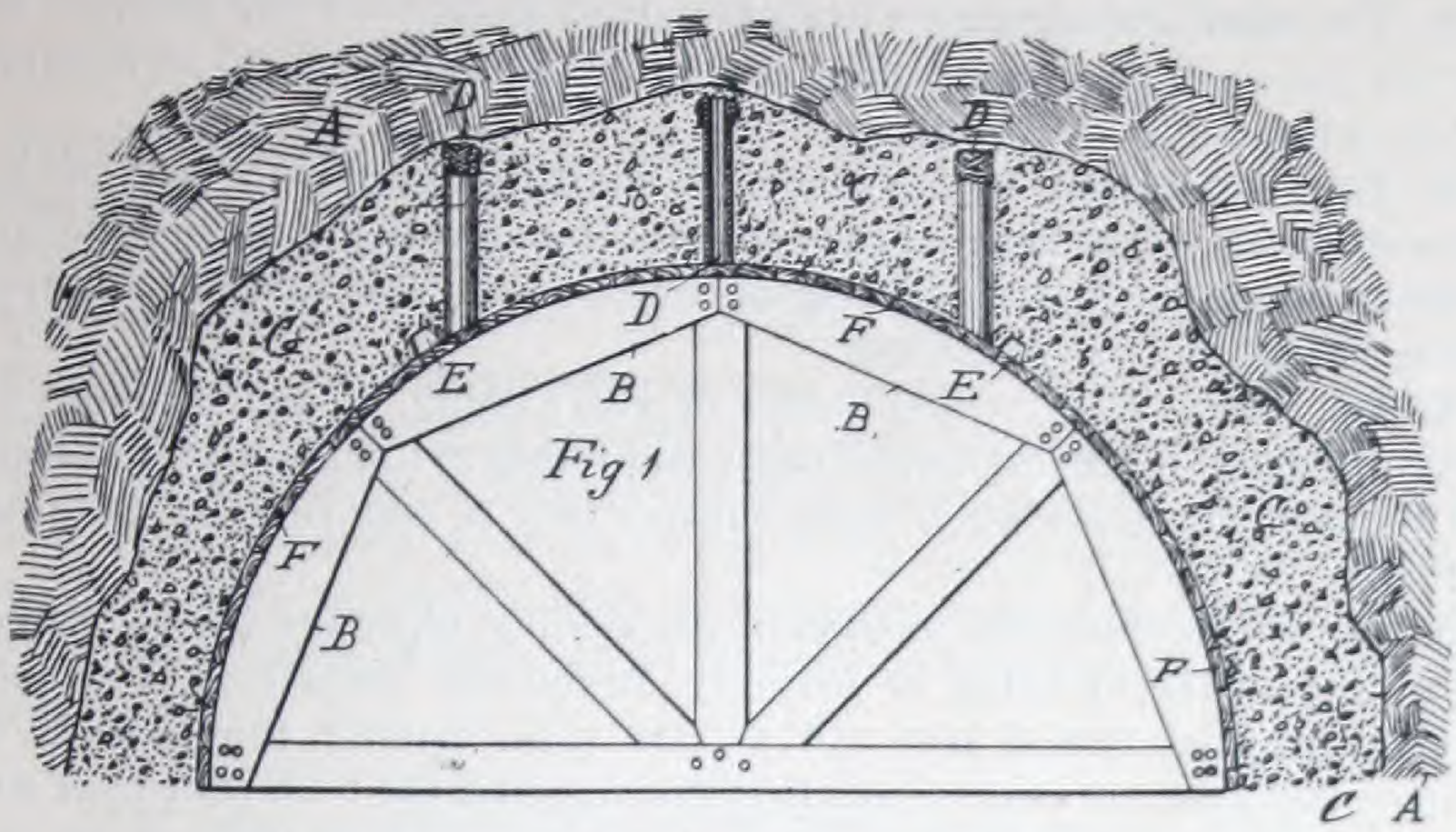
JOHN C. GOODRIDGE, JR., of New York, N. Y.

Process of and Device for the Construction and Repair of Tunnels and Shafts.

Patent No. **303,506,** dated August 12, 1884.

Application filed January 2, 1884. (No model.)

Fig. 5.



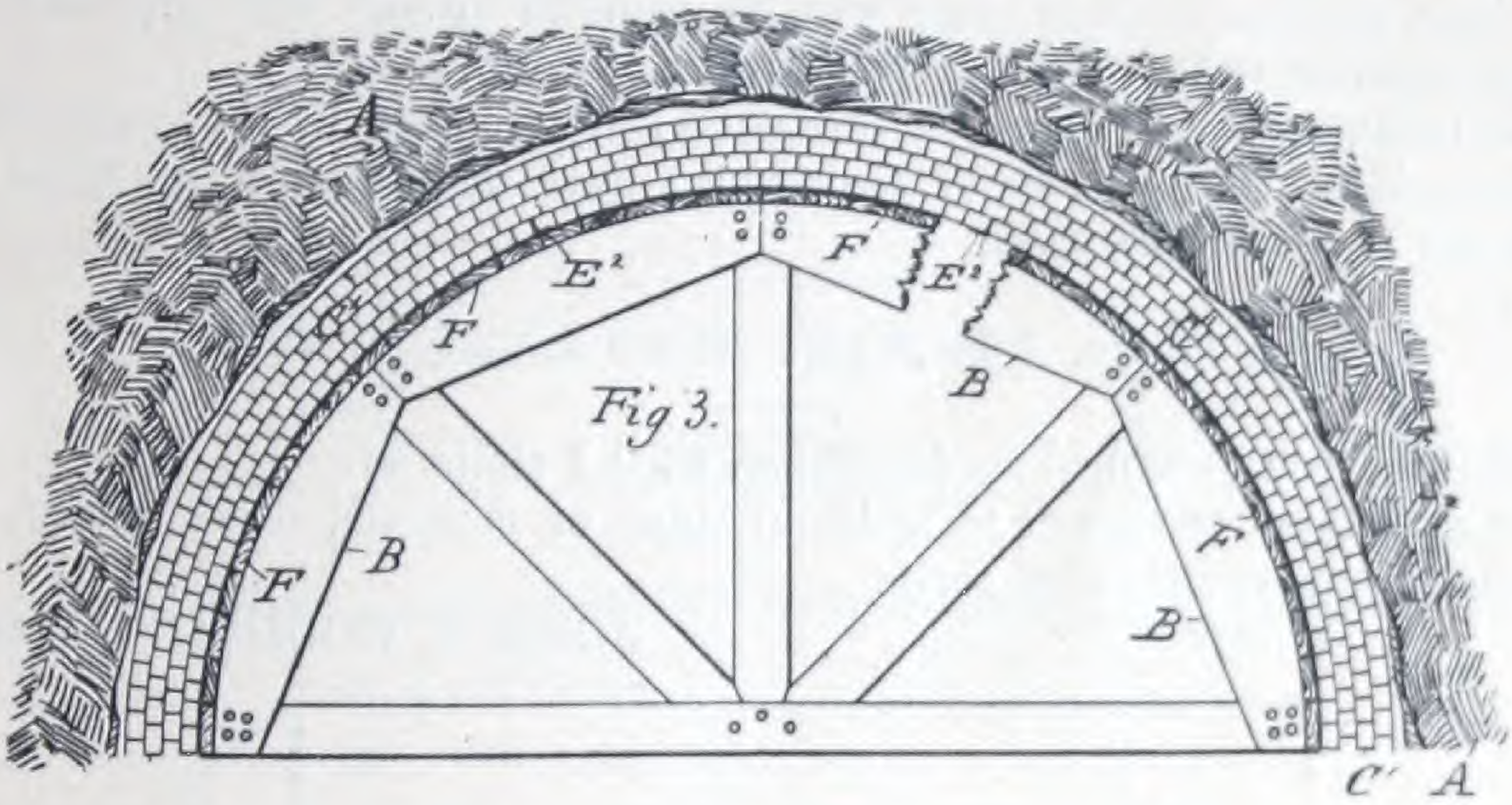
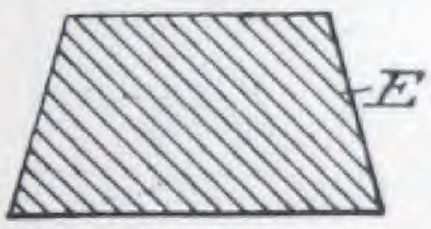
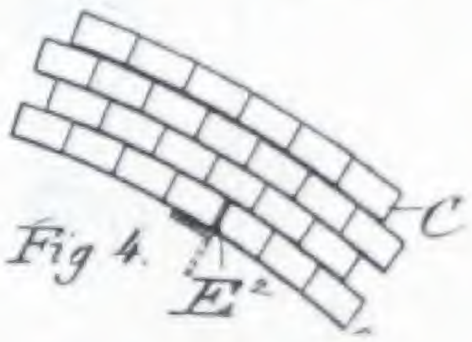


Fig 2.





Having now described my invention, what I claim as new, and desire to secure by Letters Patent, is:

1. The within-described process of lining tunnels and shafts with beton or masonry in the presence of infiltrating water, consisting of erecting a water-tight lagging within the tunnel or shaft, substantially parallel to and at any desired distance from the interior thereof, filling the space so formed with beton or masonry, allowing said lagging to remain in position until said beton or the cement in which the masonry is laid has set, and then removing said lagging.

2. The combination, with a tunnel or shaft lining, of one or more water bars for the purpose of controlling and localizing the discharge of infiltrating water, substantially as described.

3. The combination, with a tunnel or shaft lining, of one or more waste water discharge-pipes inserted through said lining at the point of infiltration, or above that point, for the purpose of controlling or leading away infiltrating water, substantially as described.

4. The combination, with a tunnel or shaft lining, of one or more waste water discharge-pipes inserted through said lining at the point of infiltration, and above one or more water bars, substantially as and for the purpose set forth.

5. The within-described method of embedding pipes for the discharge of infiltrating water in beton or masonry structures, consisting of wrapping pervious material around one end of said pipe, placing the pipe in such position that that end may be nearly in contact with the orifice through which the water enters, while the other or discharge end projects through the work, and then packing beton or other suitable material around said pipe and pervious material, substantially as described.

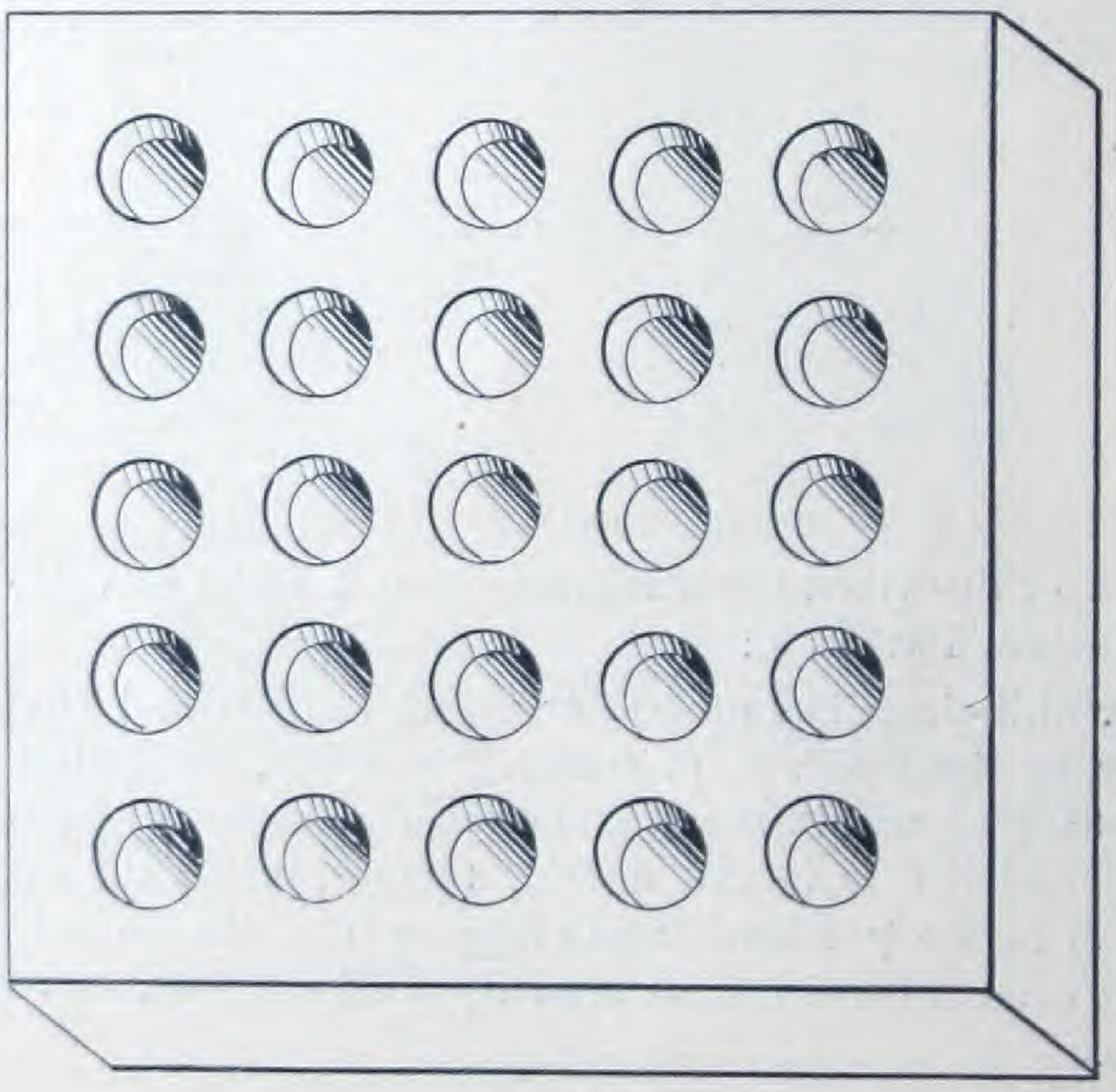
In testimony that I claim the foregoing improvement in the construction of tunnels and shafts, as above described, I have hereunto set my hand this 28th day of December, 1883.

Patent No. **148,818.** Dated January 24, 1874.

Having thus described my invention, what I claim is:

A perforated pavement of artificial stone or concrete, as described, and adapted to the purposes set forth.

JOHN C. GOODRIDGE, JR.



J. C. GOODRIDGE, JR.

Method of Constructing Underground Tunnels and Arches.

No. **262,403**. Patented August 8, 1882.

Having now described my invention, what I claim as new, and desire to patent, is:

The within-described method of constructing underground tunnels or arches, consisting in forming two or more trenches, filling the same with beton, concrete, or masonry, shaping the surface of the earth contiguous thereto, and over where it is proposed the tunnel shall be, so as to conform to the inner surface of the roof of the proposed tunnel or arch, building the roof of said tunnel or arch upon said earth, using the same to support the work while in process of construction, and subsequently excavating the earth enclosed between said walls and roof, in order to form the tunnel, substantially as described.

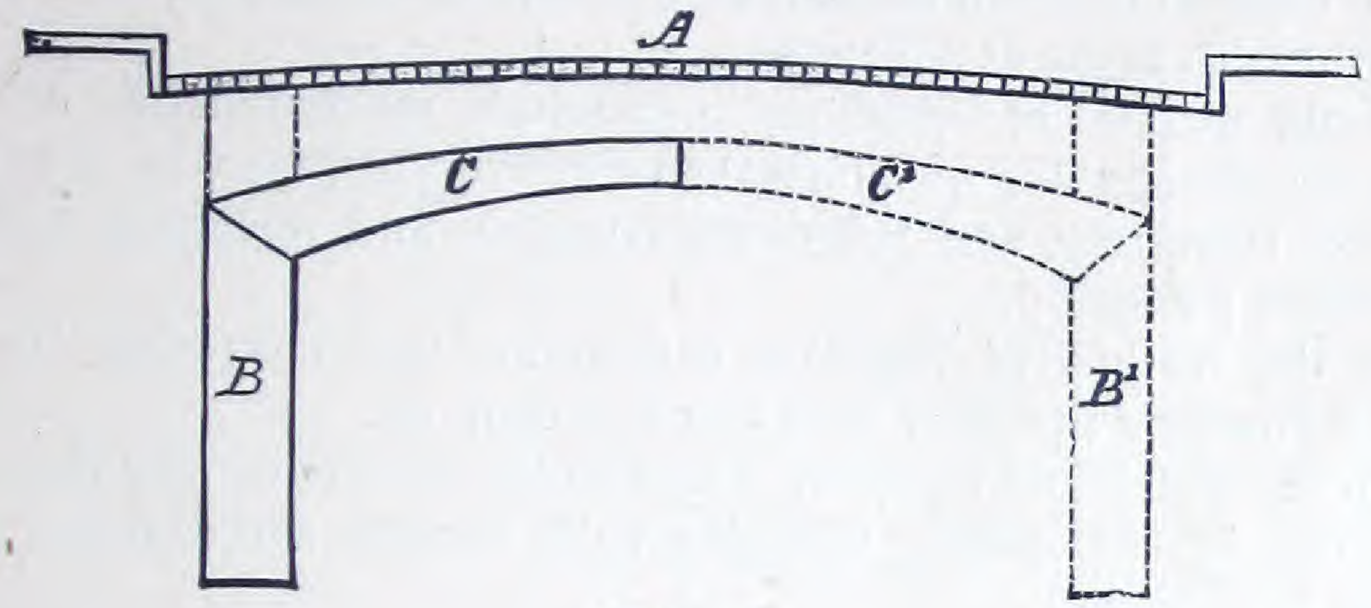


Fig. 1.

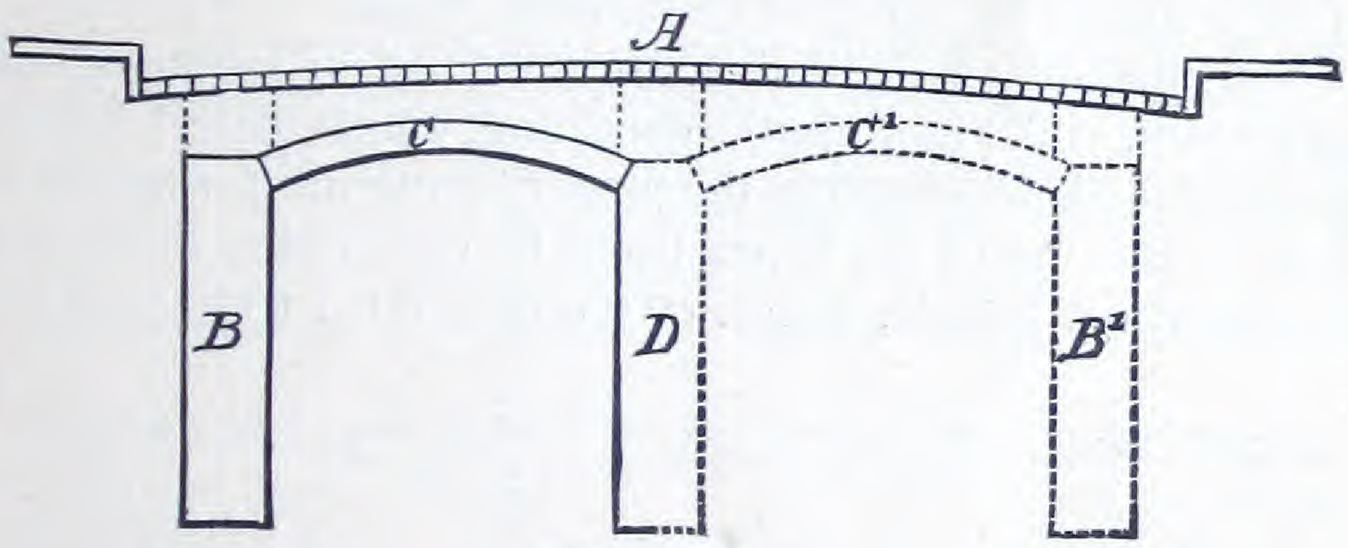


Fig. 2.

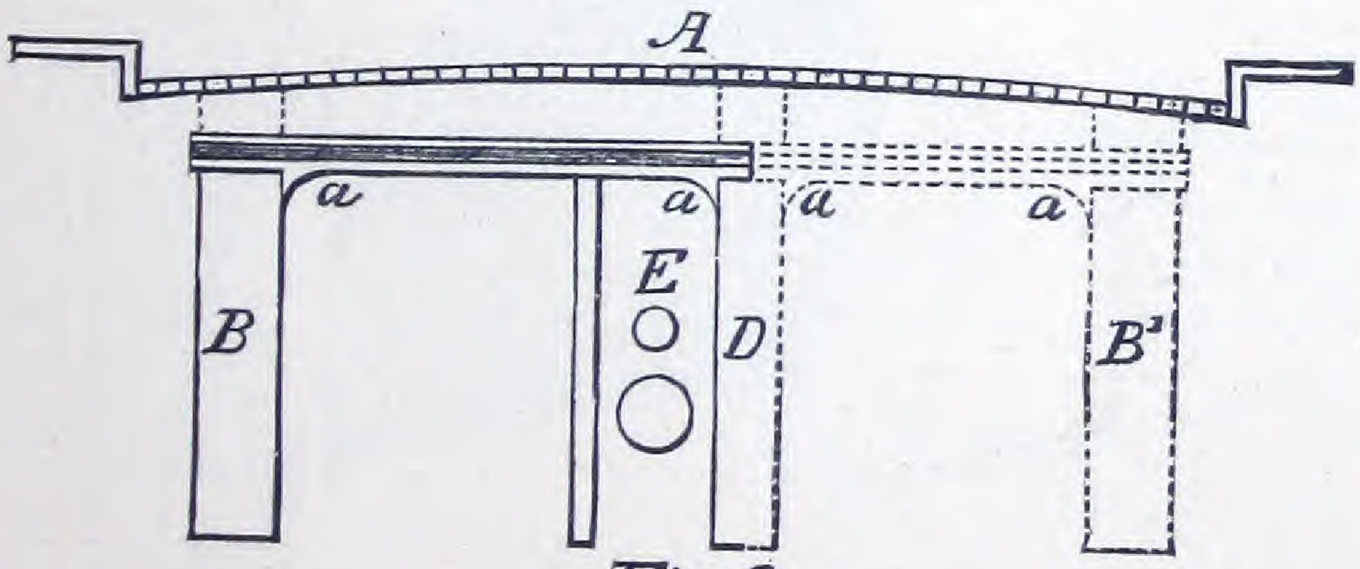


Fig. 3.

Canada.

Patent of Invention to John C. Goodridge, Jr.

The present patent grants to the said John C. Goodridge, Jr., his executors, administrators, or assigns, for the period of fifteen years from August 25, 1882, the exclusive right, privilege, and liberty of making, constructing, and using, and vending to others to be used, the said invention of John C. Goodridge, Jr., and which is called and known by the title or name of

"Improvement in Methods of Repairing Structures with Beton or Concrete,"

and whereof a short description is as follows:

It consists: 1st. In the method of repairing structures with beton or concrete, by surrounding the same more or less completely with moulds, leaving an interval between the said moulds and the structure, and then filling said interval with beton or concrete.

2d. In the method of repairing a structure the foundation of which is defective, by surrounding or facing the defective portions with a wall placed at a distance therefrom, and thence undermining and replacing such defective foundation piecemeal.

3d. In the method of repairing a structure and increasing its bearing surface, by encasing the same with beton or concrete.

4th. In the method of repairing a pile bridge and converting the same into a pier bridge, by surrounding said piles with moulds, and encasing the same with beton or concrete.

5th. In the method of filling moulds containing water, to repair structures with beton or concrete by means of an inclined plane.

6th. In the method of lightening work formed of beton or concrete, by embedding therein, while in a plastic condition, empty barrels or boxes.

7th. In the method of increasing the mass of structure formed of beton, and economizing in the use of the beton itself, by embedding in the same, while in a plastic condition, barrels, boxes, or the like, filled with stones or earth.

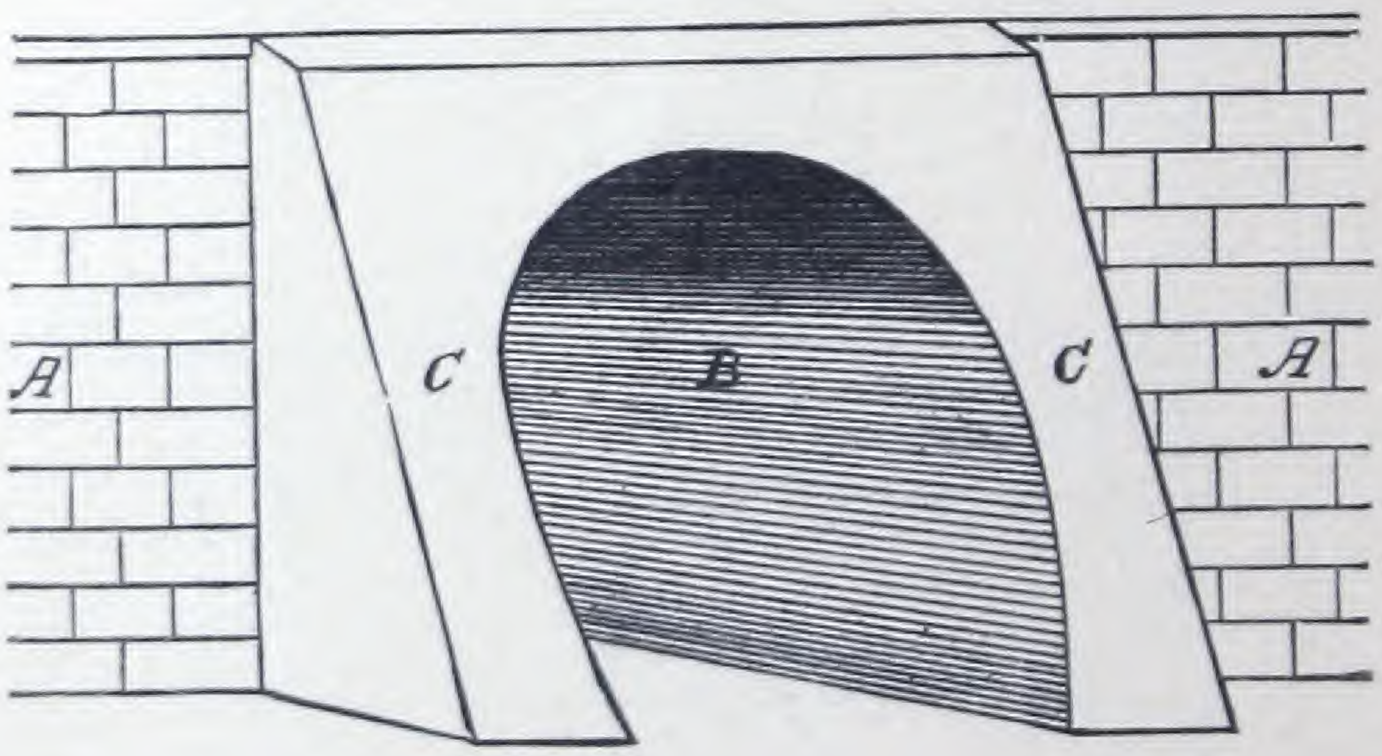


Fig. 1.

Plate of Canada Patent.

FIG. 2.

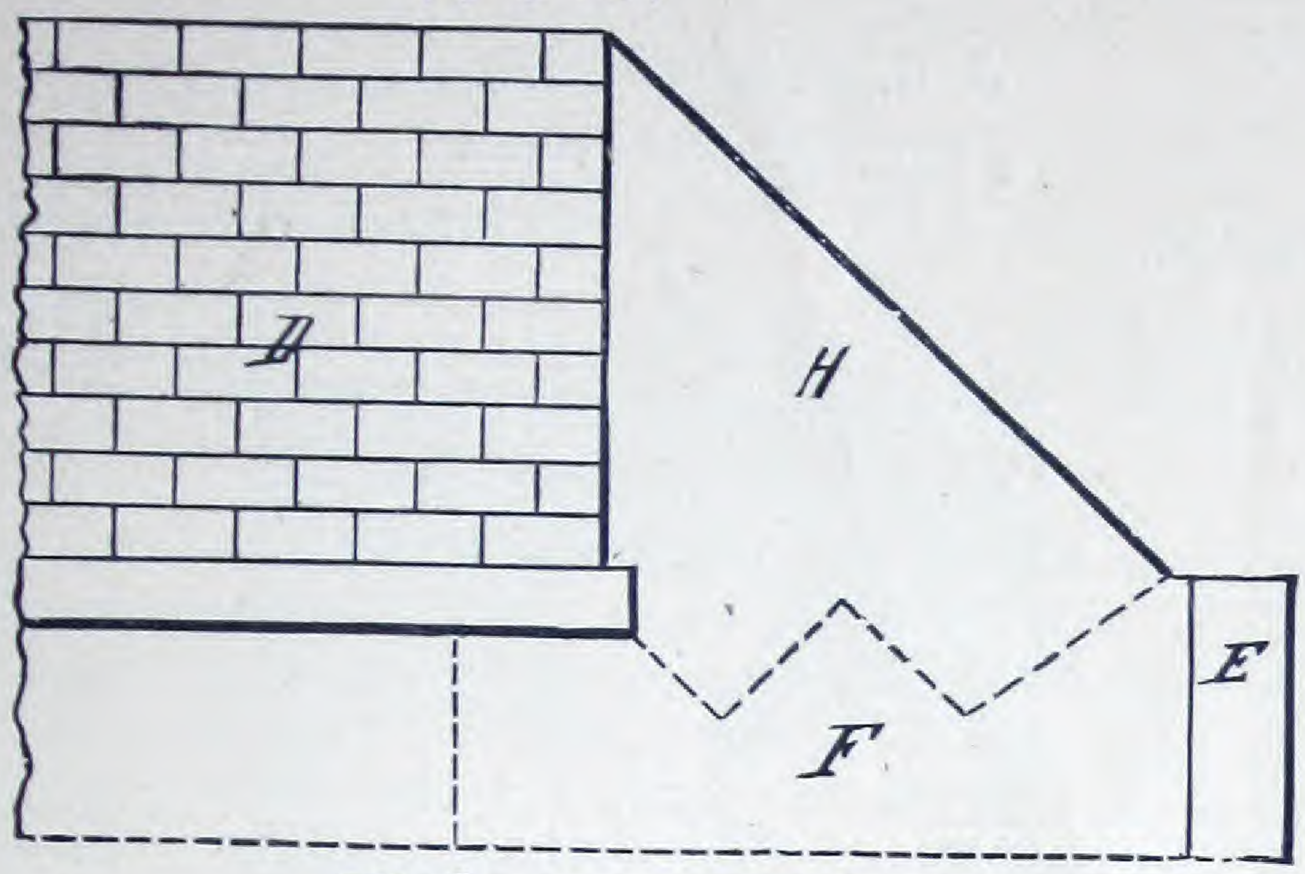


FIG. 3.

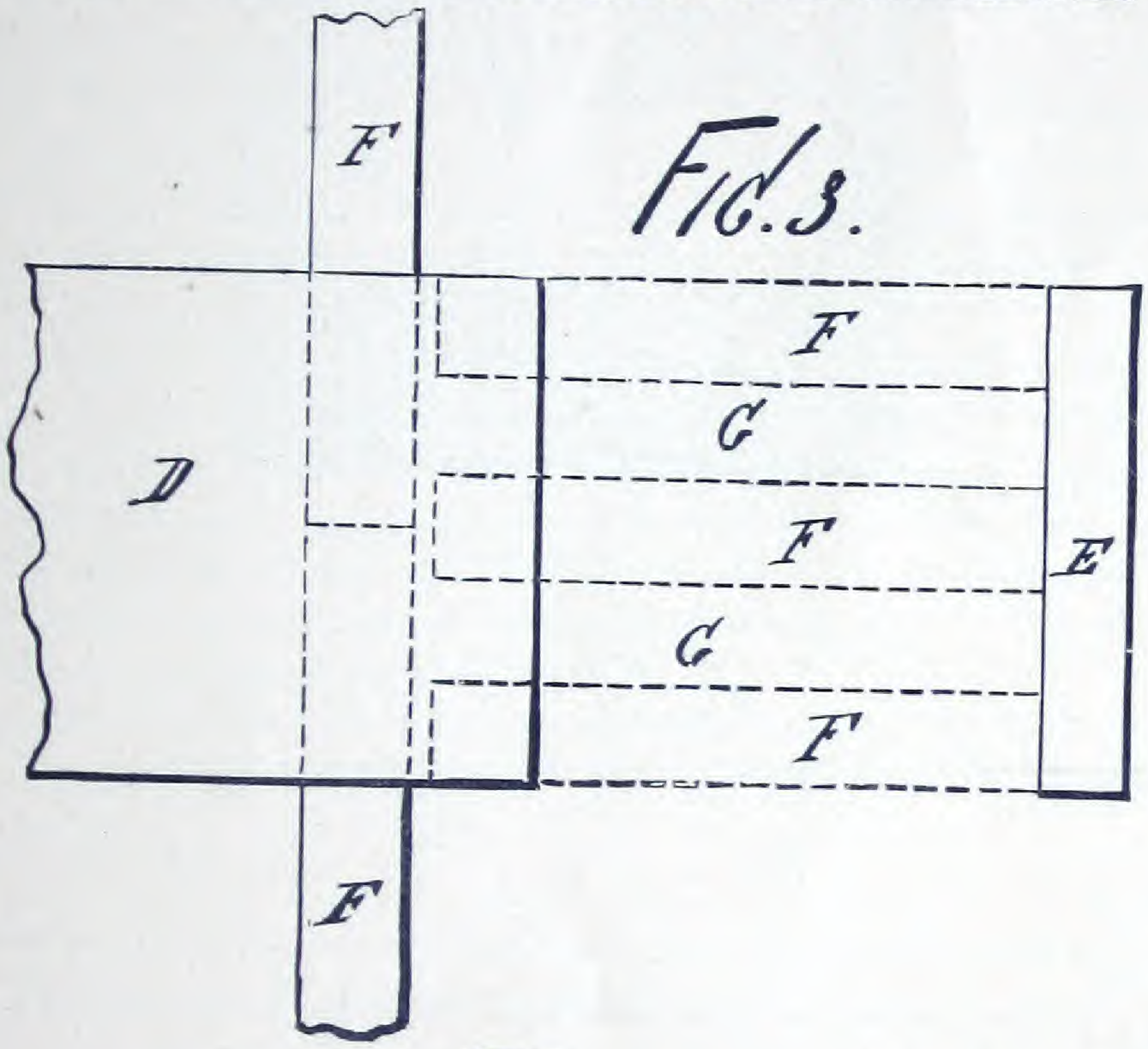
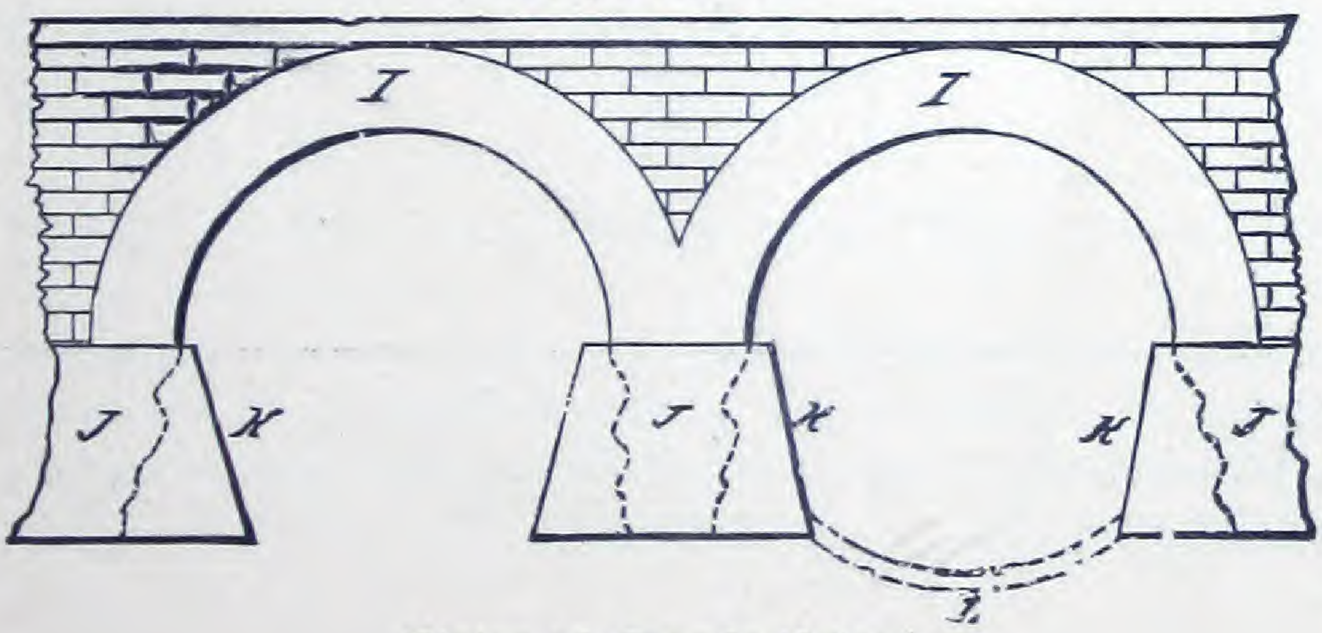


FIG. 4.



Plates of Canada Patent.

(No Model.)

J. C. GOODRIDGE, Jr.

ELECTRIC WIRE DUCT.

No. 278,233. Patented May 22, 1883.

FIG. 1.

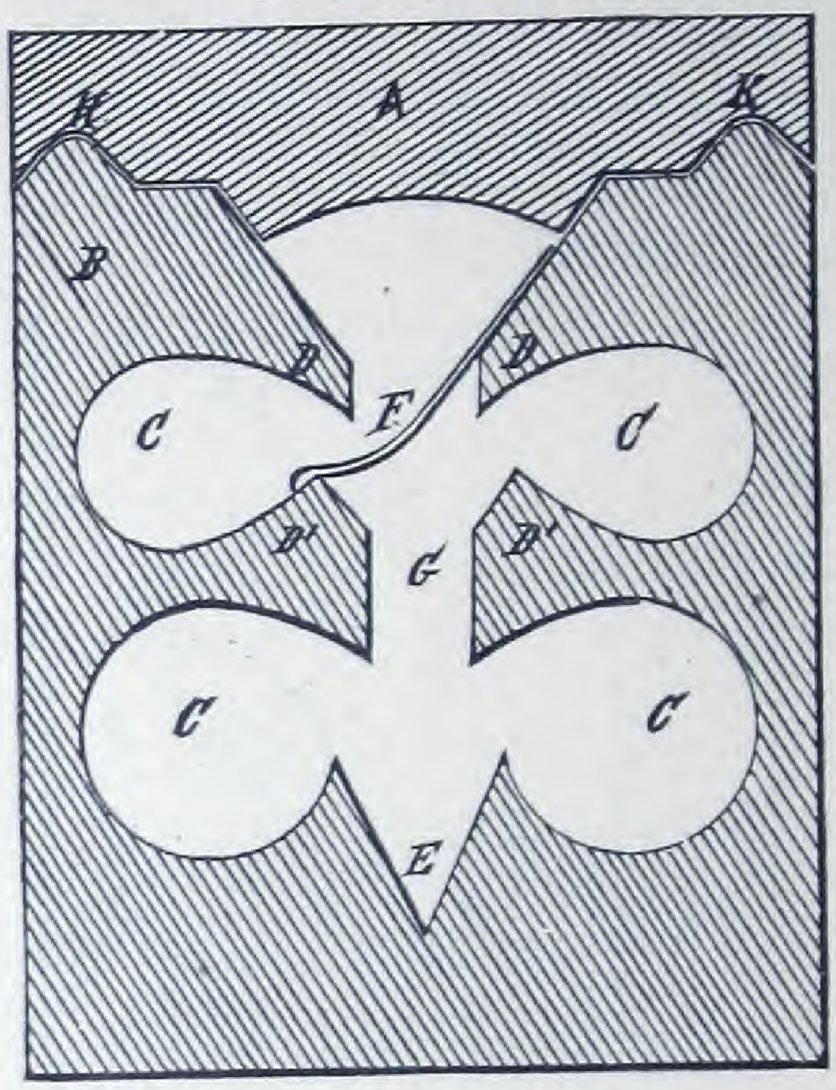
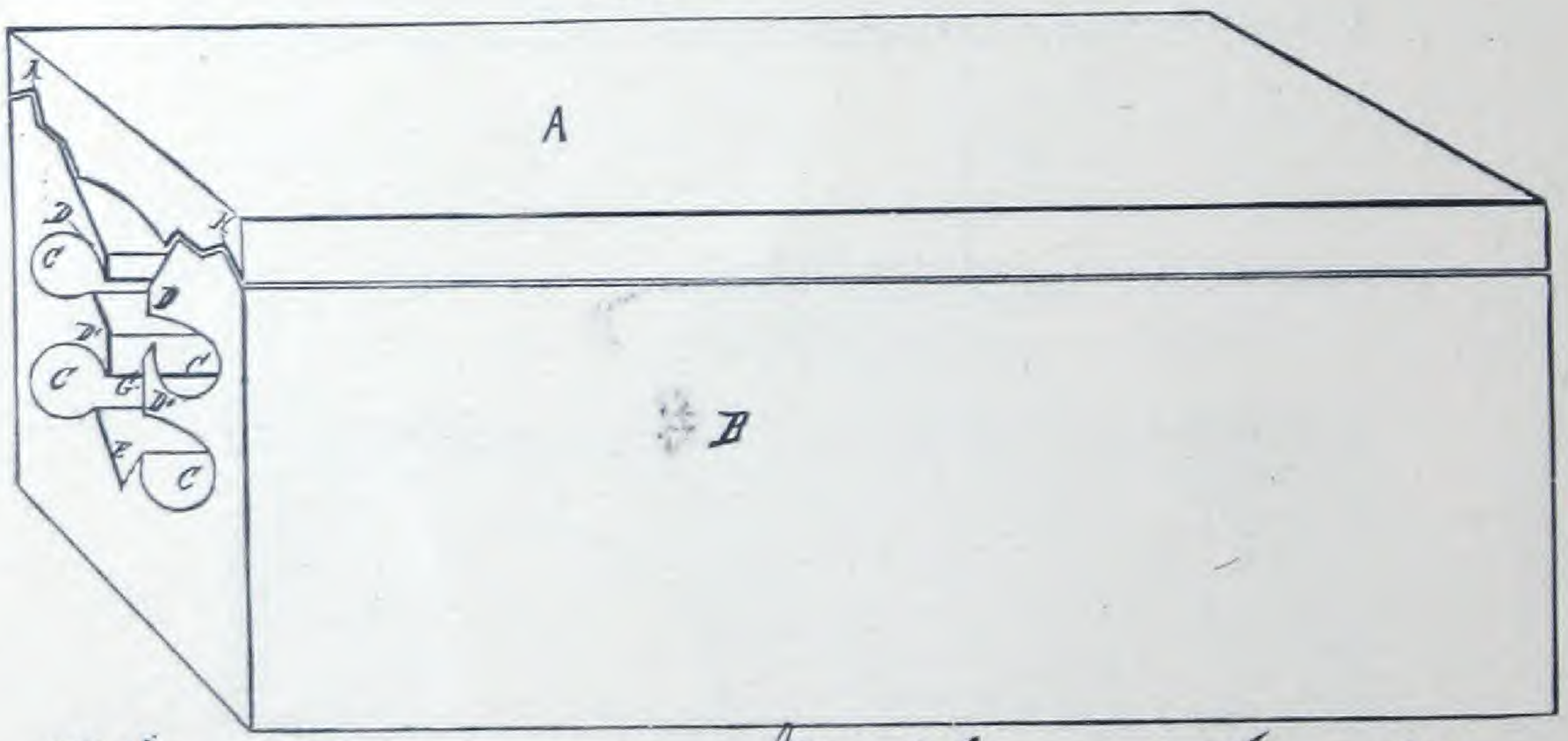


FIG. 2



Witnesses
R. F. Van Rockerck
John Buckler

John C. Goodridge Jr. Inventor
by Henry P. Wells his Atty.

UNITED STATES PATENT OFFICE.

JOHN C. GOODRIDGE, JR., of New York, N. Y.

Electric-Wire Duct.

Specification forming part of Letters Patent No. **278,233,** dated May 22, 1883; application filed August 26, 1882. (No model.)

Having now described my invention and the method of using the same, what I claim as new, and desire to patent, is—

1. A conduit for electrical wires, consisting of a series of pockets opening laterally into a central aperture, each pocket so constructed as to form a ledge, whereby falling earth and water are diverted into said central aperture and thence into a suitable drain, the whole closed with a suitable cover, substantially as specified.

2. A conduit for electrical wires, consisting of a series of pockets openign laterally into a central aperture, said aperture forming at its bottom a suitable drain, the said pockets provided with overhanging ledges, so constructed that falling earth and water is directed to the drain below, the whole closed by a cover, substantially as specified.

3. A conduit for electrical wires, consisting of a receptacle provided with a series of pockets, each pocket so constructed as to form a ledge, whereby falling earth and water are excluded from the pockets, said pockets opening laterally into a central aperture, which terminates at its bottom in a drain, and a guide, *F*, so arranged that the wire to be laid may be placed upon said guide and thence directed to its appropriate pocket, the whole provided with a suitable drain, substantially as specified.

In testimony that I claim the foregoing improvement in electric-wire ducts, as above described, I have hereunto set my hand this 14th day of August, 1882.

JOHN C. GOODRIDGE, JR., of New York, N. Y.

Apparatus for Erecting and Supporting Colossal Structures.

Patent No. **289,644,** dated December 4, 1883. Application filed April 28, 1883. (No model.)

Having thus described by invention, what I claim as new, and desire to secure by Letters Patent, is:

1. The combination, with the structure and its pedestal or pier foundation, of one or more sectionally constructed metal columns or tubes, arranged within the structure and projecting down within the foundation, and braces connecting the structure with said column or columns, substantially as specified.

2. The combination, with the structure to be raised, of the interior sectionally constructed column, *E*, arranged with the structure, the pier foundation or pedestal, *C C'*, and the fixed jack, *I*, applied centrally beneath said column, essentially as herein described.

3. The combination of one or more sectionally constructed columns, having certain of their sections provided with guides or projections, *m*, with the rings, *s*, having ways, *n*, the hollow pedestal, *C C'*, and the structure, *B*, to which said column or columns are secured internally, substantially as specified.

4. The combination of the stationary lifting-jack or device, *I*, the sectionally constructed column or columns, *E*, the hollow pedestal, *C C'*, the movable jacks, *D D*, the structure, *B*, and means for securing the column or columns, *E*, to said structure, *B*, essentially as described.

5. The combination, with a hollow structure, to be raised, and its pedestal or pedestal base, of a lifting support applied to the structure, and constructed of a column, *E*, posts or uprights, a^3, and braces, a^2, arranged to connect said posts with each other and with the tube, substantially as specified.

(No Model.) 6 Sheets—Sheet 1.

J. C. GOODRIDGE, Jr.

APPARATUS FOR ERECTING AND SUPPORTING COLOSSAL STRUCTURES.

No. 289,644. Patented Dec. 4, 1883.

Fig. 1.

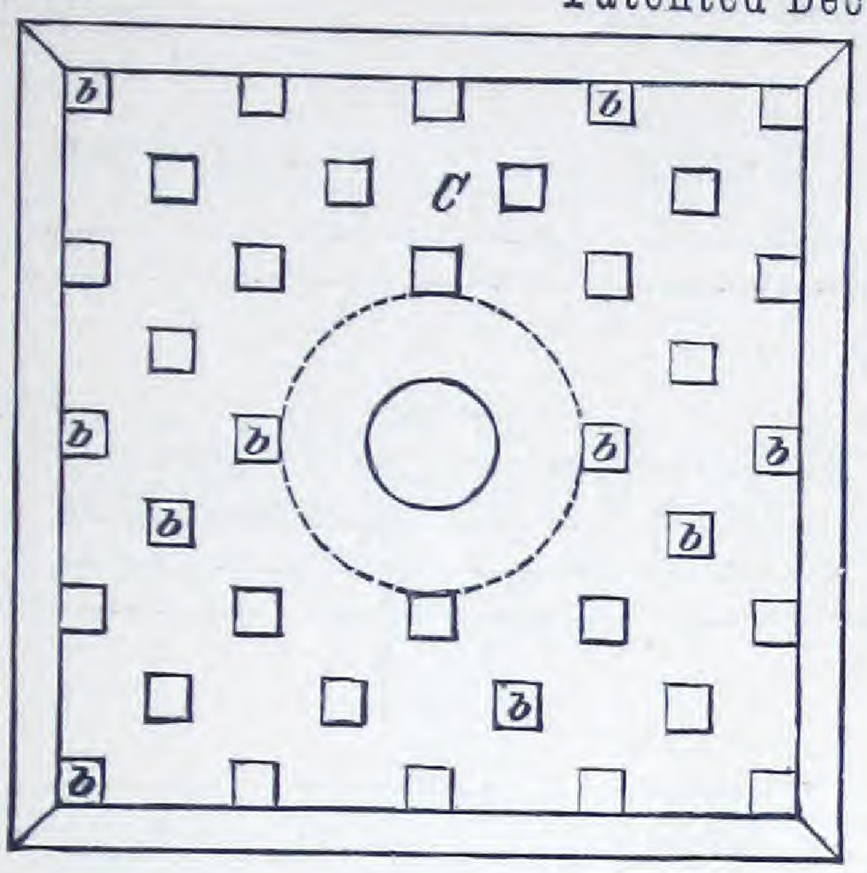
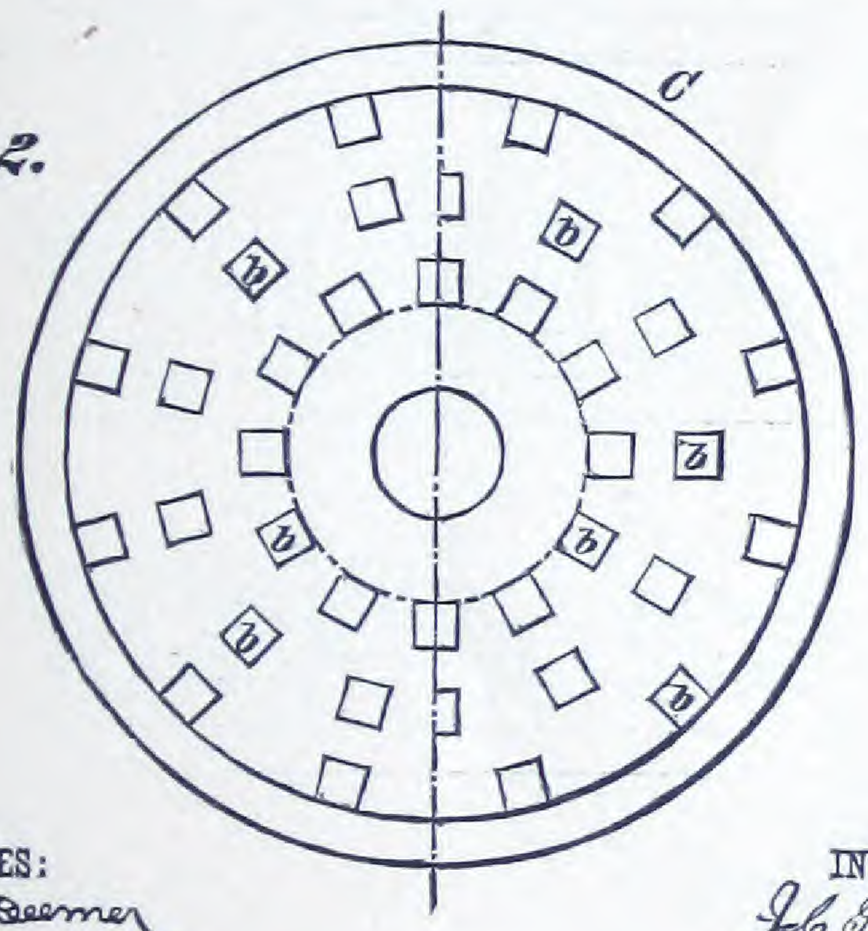


Fig. 2.



WITNESSES:

INVENTOR:

BY

ATTORNEYS.

(No Model.) 6 Sheets—Sheet 2.

J. C. GOODRIDGE, Jr.

APPARATUS FOR ERECTING AND SUPPORTING COLOSSAL STRUCTURES.

No. 289,644. Patented Dec. 4, 1883.

Fig. 3.

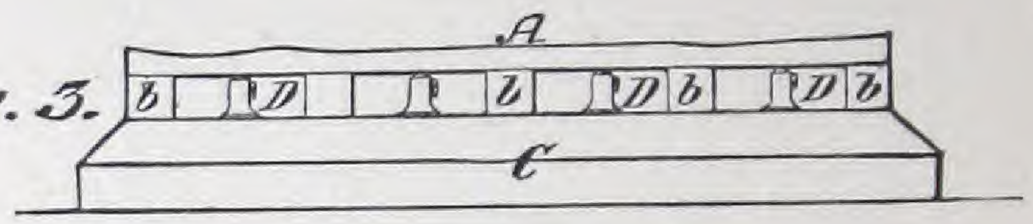


Fig. 4.

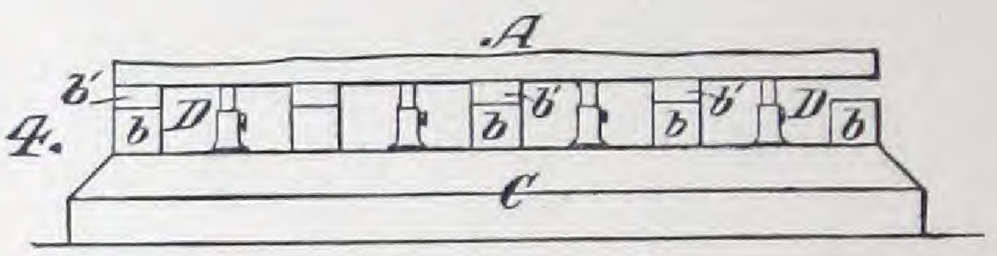


Fig. 5.

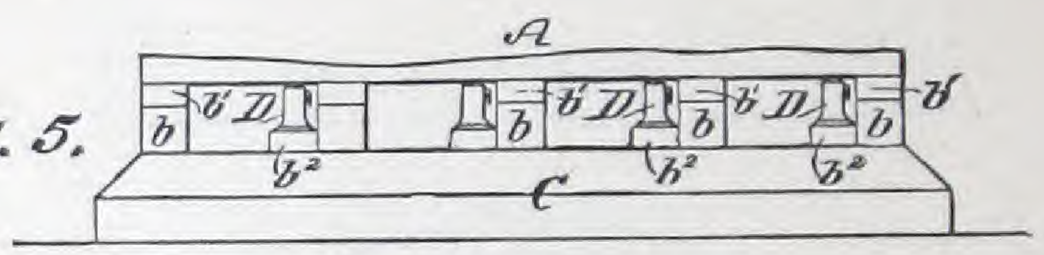


Fig. 6.

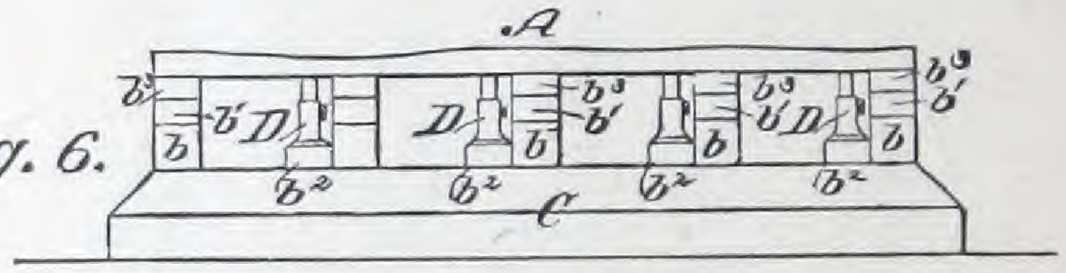
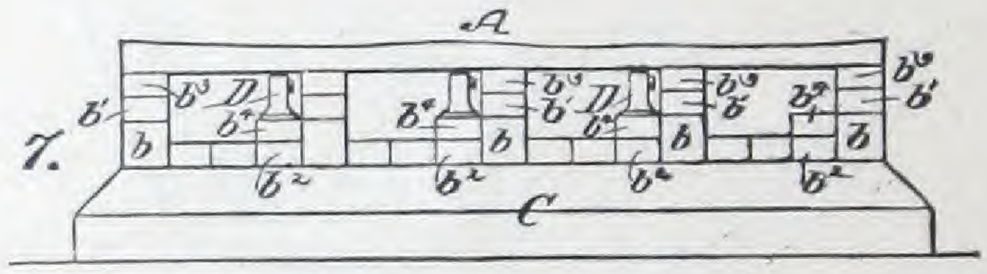


Fig. 7.



WITNESSES:
Dorner G. Beemer
L. Bruguiere

INVENTOR:
J. C. Goodridge, Jr.
BY Munn & Co
ATTORNEYS.

(No Model.) 2 Sheets—Sheet 1.

A. C. GOODRIDGE, Jr.

APPARATUS FOR REMOVING AND SUBSTITUTING DEFECTIVE STRUCTURES.

No. 289,644. Patented Dec. 4, 1883.

Fig. 2.

WITNESSES:

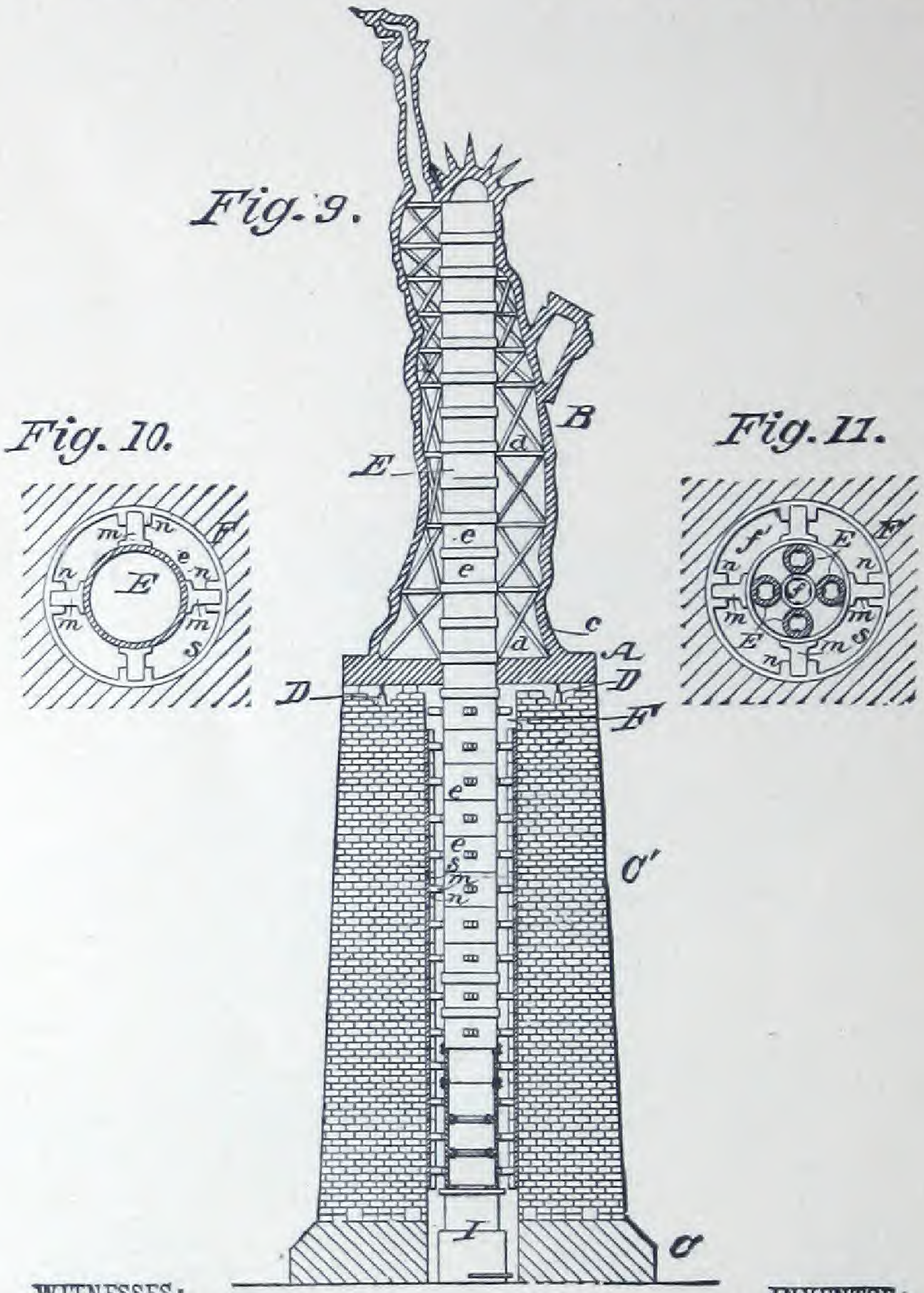
INVENTOR:

(No Model.) 6 Sheets—Sheet 4.

J. C. GOODRIDGE, Jr.

APPARATUS FOR ERECTING AND SUPPORTING COLOSSAL STRUCTURES.

No. 289,644 Patented Dec. 4, 1883.



WITNESSES:

INVENTOR:

J. C. Goodridge Jr.

BY

ATTORNEYS.

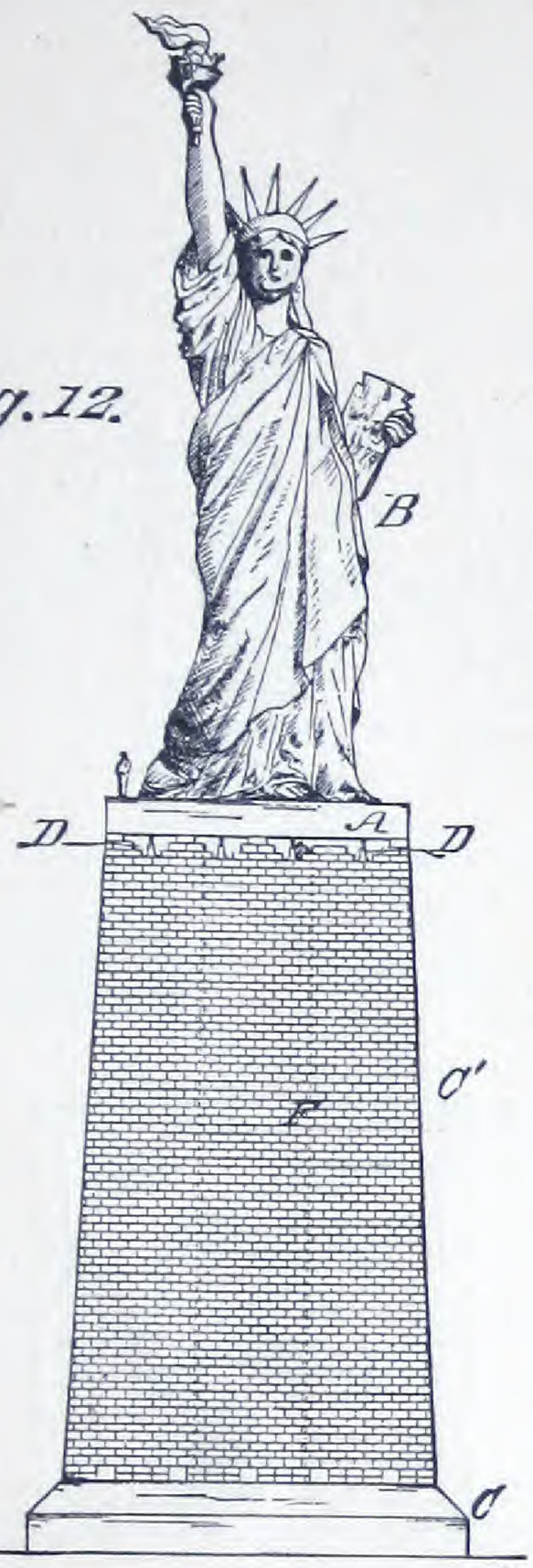
(No Model.) 6 Sheets—Sheet 5.

J. C. GOODRIDGE, Jr.

APPARATUS FOR ERECTING AND SUPPORTING COLOSSAL STRUCTURES.

No. 289,644. Patented Dec. 4, 1883.

Fig. 12.



WITNESSES:

Dorner G. Beemer

H. Sedgwick

INVENTOR:

J. C. Goodridge Jr

BY

ATTORNEYS.

(No Model.) 6 Sheets—Sheet 6.

J. C. GOODRIDGE, Jr.

APPARATUS FOR ERECTING AND SUPPORTING COLOSSAL STRUCTURES.

No. 289,644. Patented Dec. 4, 1883.

Fig. 13.

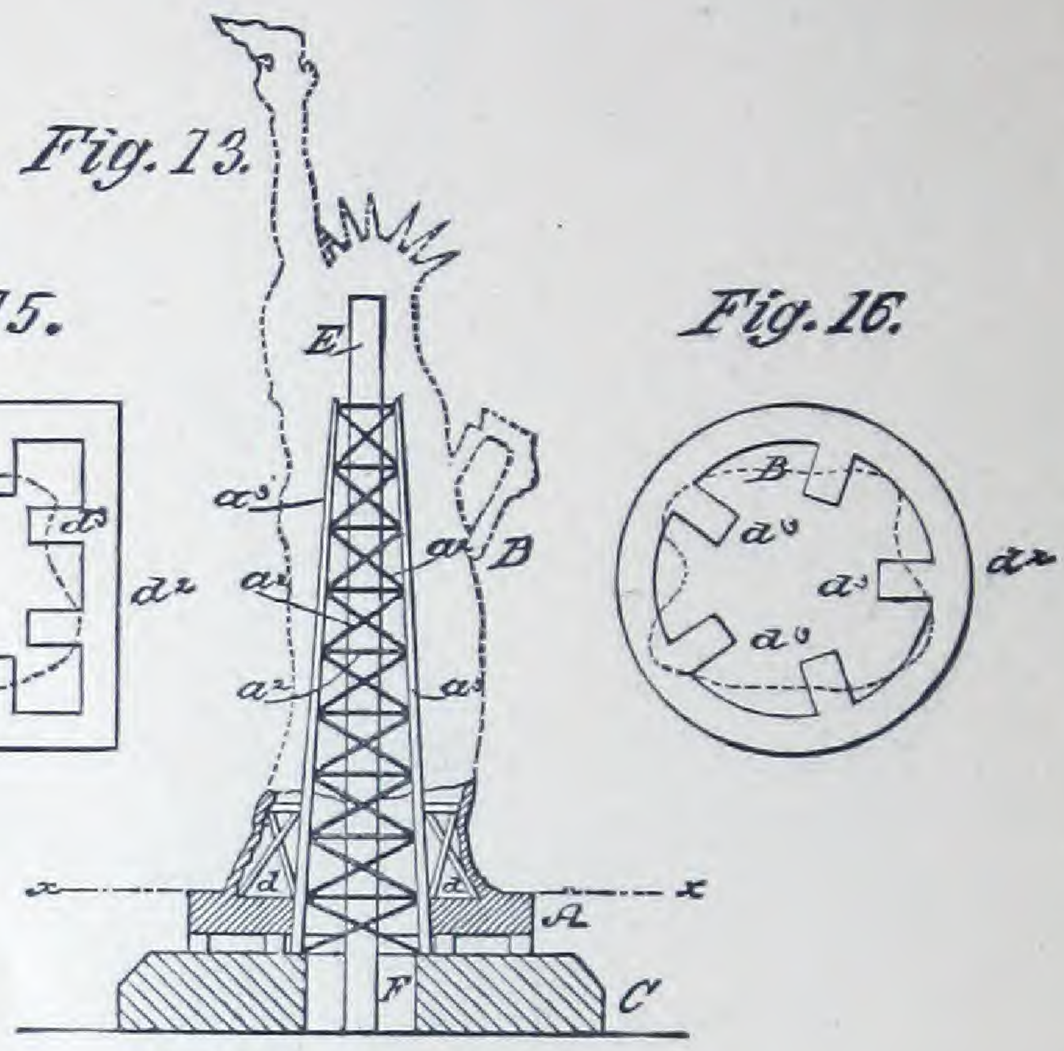


Fig. 15.

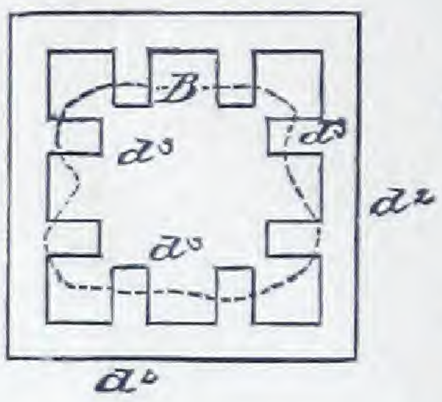
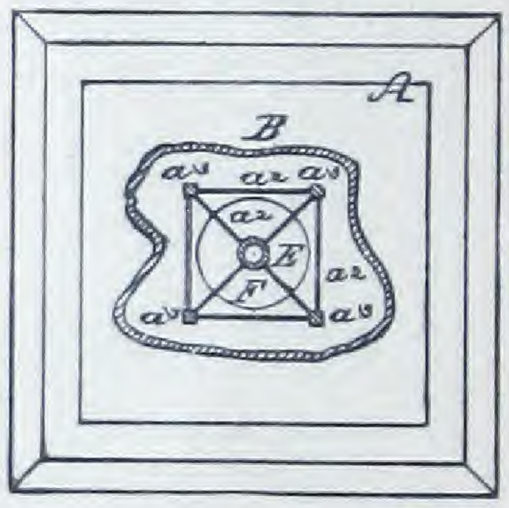


Fig. 16.

Fig. 14.



WITNESSES:
Dorsey & Seeman
L. Burgunder

INVENTOR:
J. C. Goodridge Jr.
BY
ATTORNEYS.

(No Model.) 2 Sheets—Sheet 1.

J. C. GOODRIDGE, Jr.

PROCESS OF DEEPENING AND MAINTAINING CHANNELS FOR NAVIGATION.

No. 320,129. Patented June 16, 1885.

Fig. 1.

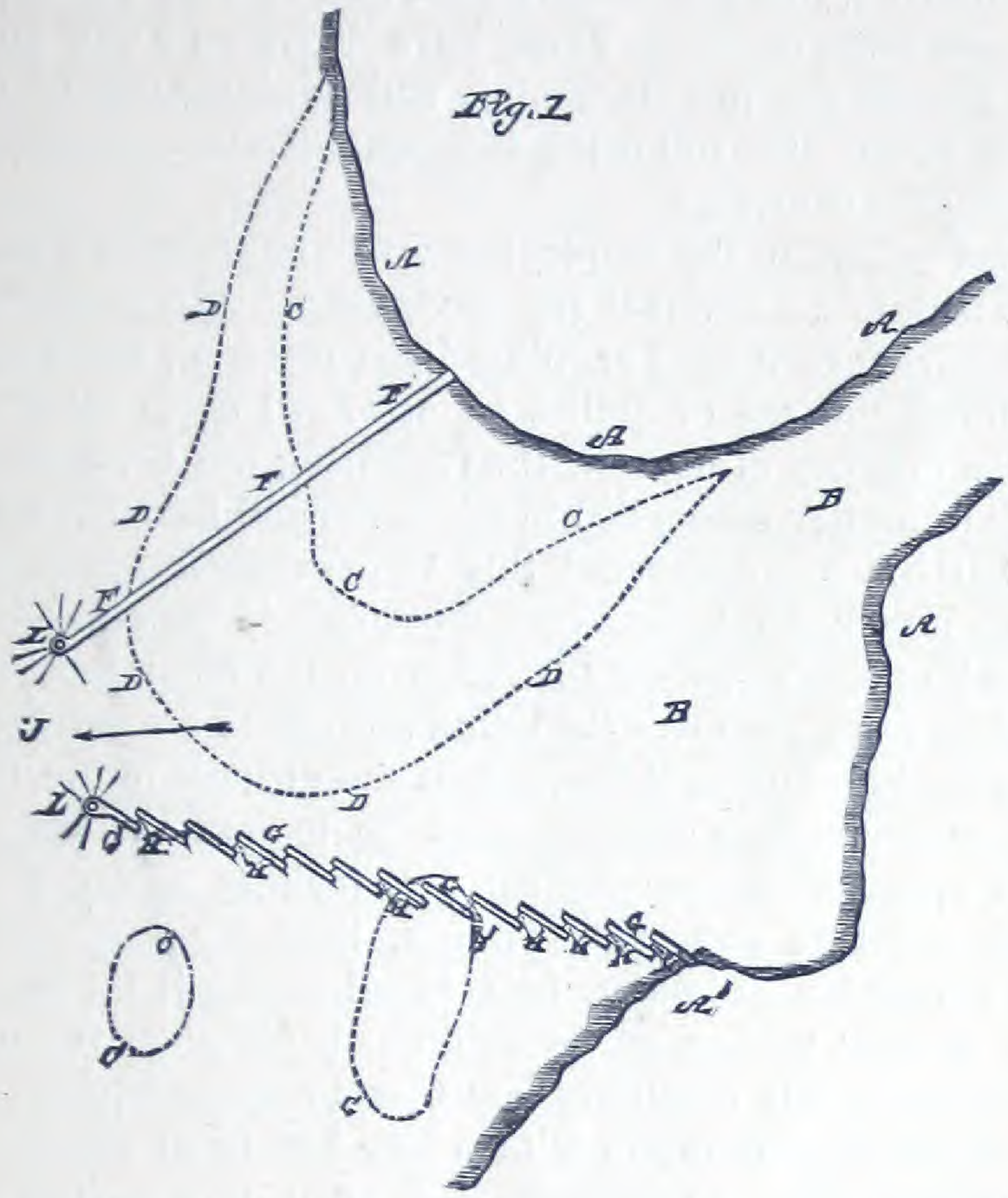
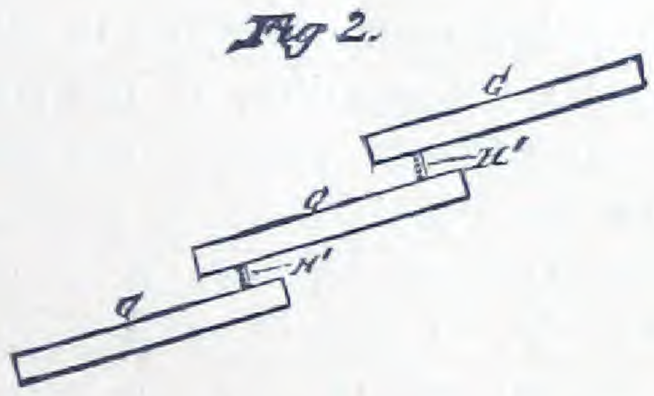


Fig 2.



UNITED STATES PATENT OFFICE.

JOHN C. GOODRIDGE, JR., of New York, N. Y.

Process of Deepening and Maintaining Channels for Navigation.

Specification forming part of Letters Patent No. **320,129,** dated June 18, 1885. Application filed March 5, 1885. (No model.)

To all whom it may concern:

Be it known that I, JOHN C. GOODRIDGE, JR., of New York, in the county of New York and State of New York, have invented a new and useful Improvement in Process for the Deepening and Maintenance of Channels for Navigation, of which the following is a specification, reference being had to the accompanying drawings.

My invention relates to the employment of the scour of a natural current to deepen and maintain a channel for navigation. When the bed of a river or the bar of a harbor is of sand or other light material, beneficial result has heretofore followed the use of jetties so arranged as to localize the current and increase the rapidity of its flow, thus scouring out the sand and preventing the deposit of matter suspended in the water and borne down from above. But as far as harbors are concerned this improvement has in all cases been limited to those into which large rivers flow, and in which therefore the discharge on the ebb greatly exceeds the influx on the flood; but this is not the case with tidal harbors, for there the influx and efflux are substantially equal. To surmount this difficulty in these cases is the purpose of my invention. All action toward maintaining a channel must be toward the sea—that is, outward. This I propose to accomplish by making many points of inlet, thus obtaining a diffuse and gentle influx, then, by impounding and embaying a large quantity of water, and so directing it on its outward passage that the greater portion of its volume is directed through the space desired as a channel, the conditions existing in those harbors fed by large rivers are practically reproduced, with a like beneficial effect.

In the drawings, Fig. 1 represents the plan of a harbor to which my improvement has been applied; and Fig. 2 a series of sectional jetties, the space between the overlapping ends of which is closed by tidal gates.

In Fig. 1, A represents the shore line; B, the roadstead or harbor; C, the ten foot line of a shoal, and D, the twenty foot line of said shoal. By the natural action of the sea the shoal, C D, is gradually extended toward the point, A′, until the roadstead or harbor, B, is gradually closed up, the shore, A, working over to A′. I should meet such a contingency by interposing the continuous breakwater, F, in the path of the motion. Then from a point on the opposite shore, A′, I extend a series of short breakwaters placed nearly parallel, and at a little distance from one another and at a small angle with the channel, the ends of which overlap, all as shown in Fig. 1. The rising tide then enters all the openings, H, the angle with which it impinges on the jetties directing it to and through the intervals. It avails itself of the channel, J, as well, and thus a comparatively gentle and uniform influx is obtained; but when the tide turns to ebb, the current

would encounter the jetties at a different angle, and be in large measure deflected by the openings, H, and out through the channel, J. Thus the requisite conditions to success—a gentle and general inflow and a comparatively rapid and localized outflow—are obtained.

The flood and ebb tide seldom, if ever, follow the same path. Not only is this so as to the mean or average direction of these currents, but seldom or never does the same current follow the same direction throughout its duration. For example, let us refer to the Atlantic Coast Pilot, 1878—Boston to New York, Appendix No. 1—Rate and direction of current for each tidal hour after time of high water at Boston gave as follows: Northern Channel, E. by N.; S. E.; S. E. ½ S.; S. by E.; S.; W. by N.; N. W. by W.; N. W. by W.; N. N. W.; N. by E. We find from that appendix that in the northern channel the ebb makes an average direction of S. by E., and that the flood makes an average direction of W. N. W., a departure of 60 degrees from a straight line. We also find that the tide moved in every direction except between the points N. by E. and E. by N., a space of 55 degrees, or, in other words, the current moved over an arc 305 out of 360 degrees. This example is selected at random, and is typical of the universal action of tidal currents. Of course an engineer skilled in the art of harbor improvement would know that every harbor or channel had its local tidal peculiarities, and would make a thorough acquaintance with that feature of the problem the first step. Then he would so locate his jetties that the incoming flood should be directed to and find easy access at the proper intervals, while the outgoing current would strike the jetties at an angle calculated to deflect it in great part past the openings to find an exit at the main outlet.

That law of nature which compels all moving bodies, fluid as well as solid, to follow the line of least resistance is the root of this matter, for it is clear that if the ebb follows the direction of the arrow in Fig. 1, the current strikes the jetties at such an angle as to glance from them, so to speak; nor can it escape through the openings between the jetties to any important degree, unless it returns upon itself—a thing a current never does, since that is the line of maximum resistance. Nay, further, if the outflowing current is strong, it will suck water through the openings from without, and as far as the current at those special points is concerned, an inflowing current will always appear there except at slack water. The ordinary expirator and inspirator, the spray atomizers, the Bunsen pump, and many other devices are all illustrations and embodiments of and owe their efficiency to this principle. It may be seen and studied at any time by observing the action of the water at the sides of and below a bridge pier standing in a rapid current. The downward flow drags away the water from behind the pier, which water always is lower there than the water abreast of it, where the current is unobstructed, and a return current from below much narrower than the pier will be noticed partially to supply the place of the water so abstracted. The article "Hydronamics," Encyclopædia Britannica, 8th ed., vol. xii., page 138, may be consulted in this connection.

In the preceding description we have assumed the action of the sand and deposit to be following down the coast toward the continuous breakwater, F.

If the action of the sea drive the sand directly toward the harbor from a point at right angles to it, sectional jetties can be used on both sides of the entrance and the continuous jetty, F, be omitted.

The most advantageous distance between the detached jetties, their length, and their lap will vary under different circumstances, depending on the flow of the current and the rise and fall of the tide and local topography.

During the formation of the channel, or when the rise and fall of the tide and consequent current is feeble, tidal gates may be used in the intervals, H, between the sectional jetties, G, and so arranged as to open before the incoming and close before the outgoing current, thus directing the entire ebb through the channel. If placed as shown at H′, Fig. 2, they will be protected from the violence of the sea.

It is obvious that this method is equally applicable to the improvement of a harbor into which a large river flows, since it tends to increase the disparity already exitsing between the inward and outward currents.

In the case of a harbor the usefulness of which has become seriously impaired, a beneficial result may be expedited by judicious dredging.

Having thus described my invention, what I claim as new, and desire to patent, is:

1. The within described means of making, improving, or maintaining a channel for navigation, consisting of sectional overlapping jetties placed at an angle with the outgoing current, and so arranged as to produce a comparatively gentle and diffuse current on the flood tide and a comparatively rapid current more or less restricted to the channel on the ebb tide.

2. The within described means of making, improving, or maintaining a channel for navigation, consisting of sectional overlapping jetties placed at an angle with the outgoing current, the intervals between which are closed with tidal gates, and so arranged as to afford comparatively unrestricted entrance at many points to the inflowing current, but to close against the outgoing current, and divert it, wholly or in great part, through the space intended for said channel.

In testimony that I claim the foregoing improvement in process for the deepening and maintenance of channels for navigation, as above described, I have hereunto set my hand this 30th day of December, 1884.

JOHN C. GOODRIDGE, JR.

Witnesses:

M. A. GOODRIDGE,

EMMET PHILIPS.

Patent No. **88,545**. Dated April 6, 1869.

What I claim, and desire to secure by Letters Patent, is:

1. The herein-described plastic, pulverulent artificial stone paste, composed of sand, hydraulic lime, and, in some cases, hydraulic cement, prepared substantially in the manner and for the purpose set forth.

2. In the manufacture of artificial stones, or monolithic masonry, the herein-described mode of bringing the molecules of the mass in close proximity, one to the other, and obtaining a hard stone, by means and with the use of a heavy and hard pounder, exerting its action in a systematic manner upon successive layers of artificial stone paste of the character and under the circumstances substantially as herein set forth.

3. As a new article of manufacture, the stones, or monolithic masonry, when made from the substances herein set forth, treated substantially in the manner specified.

FRANCOIS COIGNET.

Patent No. **88,546**. Dated April 6, 1869.

To all whom it may concern:

What I claim, and desire to secure by Letters Patent, is:

1. In monolithic buildings, made of agglomerated artificial stone paste, the production of flues, pipes, or openings, for the purpose of heating, ventilating, conveying water, gas, or smoke, etc., by means and with the use of proper cores introduced in the thickness of the walls, and the agglomerating around said cores of a special composition of artificial stone paste in the manner and for the purpose herein set forth.

2. In monolithic structures, such as wharves, dams, abutment walls, etc., making the walls hollow, or honeycombed, and filling the said hollow or cells with pounded earth, as herein set forth, for obtaining greater inertia strength, or bulk of masonry, at a reduced expense.

FRANCOIS COIGNET. [L. S.]

Patent No. **88,547**. Dated April 6, 1869.

What I do claim, and desire to secure by Letters Patent of the United States, is:

1. The combination of agglomerated artificial stone paste with iron scraps of irregular shape, such as nails, double-headed nails, or bolts, rings, hooks, clamps, wire, etc., substantially in the manner and for the purpose set forth.

2. The introduction in the body of artificial stones or in the body of artificial stone monolithic structures, made of agglomerated artificial stone paste, of skeletons, or metallic framework, linked or arranged so as to strengthen the same, substantially as specified.

3. The application of agglomerated artificial stone paste to the protection and isolating of telegraphic wires.

FRANCOIS COIGNET. [L. S.]

Patent No. **88,548.** Dated April 6, 1869.

To all whom it may concern :

What I claim, and desire to secure by Letters Patent, is:

1. The use of hydraulic cement, ground with a relatively small quantity of water into a thick, plastic paste, for cementing sand in the manufacture of agglomerated artificial stones.

2. The herein-described process of retarding the crystallization or setting of hydraulic cements, by repeated and prolonged triturations, whereby the proper amount of sand may be incoporated therewith.

3. As a new article of manufacture, the artificial stones, or monolithic structures, made of hydraulic cement and sand, prepared and agglomerated substantially in the manner herein specified.

FRANCOIS COIGNET. [L. S.]

Patent No. **88,549.** Dated April 6, 1869.

What I claim, and desire to secure by Letters Patent, is :

1. The application of heat in the preparation of artificial stone paste, either to the materials employed before being mixed, or to the mixture of the same, during the process of trituration, substantially in the manner and for the purpose set forth.

2. The manufacture of artificial stones, or monolithic structures, by means and with the use of hot agglomerated artificial stone paste, substantially prepared as herein set forth.

FRANCOIS COIGNET. [L. S.]

Patent No. **98,033.** Dated December 21, 1869.

To whom it may concern :

What I do claim as my invention, and desire to secure by Letters Patent of the United States, is:

1. Protecting the exposed corners, sides, edges, or angles of artificial stones by means and with the use of metallic shields fastened thereto, in the process of manufacturing said stone, substantially in the manner herein set forth.

2. As a new article of manufacture, a metal clad artificial stone, made substantially as herein described, for building purposes, or other wants of the arts, industry, or commerce.

FRANCOIS COIGNET.

Patent No. **98,034.** Dated December 21, 1869.

What I claim as my invention, and desire to secure by Letters Patent of the United States, is:

The herein-described mode of obtaining a masonry or block of artificial stone, of the character known as Coignet's agglomerate, without seams, beads, or partings, by means of the system of roughening of the surfaces of the strata, substantially as herein set forth.

FRANCOIS COIGNET.

Patent No. **98,035.** Dated December 21, 1869.

What I claim as my invention, and desire to secure by Letters Patent of he United States, is:

1. The inclined body, or case $P\ Q\ Q^1$, in combination with the conjoint helices $D\ S\ D\ S$, substantially as and for the purpose set forth.

2. The regulating sand-hopper, with its gate t, or equivalent device, in combination with the helices $D\ S\ D\ S$ and case $P\ Q\ Q^1$.

3. The use of one or more screws, S^1, with hopper R, and of definite rotated spur wheels and pinions $t^1\ t^2$, in combination with the helices $D\ S\ D\ S$, substantially as specified, and to the end of securing automatic feed to the malaxator.

4. The water pipe Z, and variable overflow W, or their equivalent, to obtain the effect specified upon the sand in the malaxator.

5. The conical adjustable sleeves $q\ q$, in combination with the piece Q^1 and conjoint helices $D\ S\ D\ S$.

6. The combination of the wheels $K\ K$, body $P\ Q\ Q^1$, and shafts $H\ H$, in the manner and to the end set forth.

FRANCOIS COIGNET.

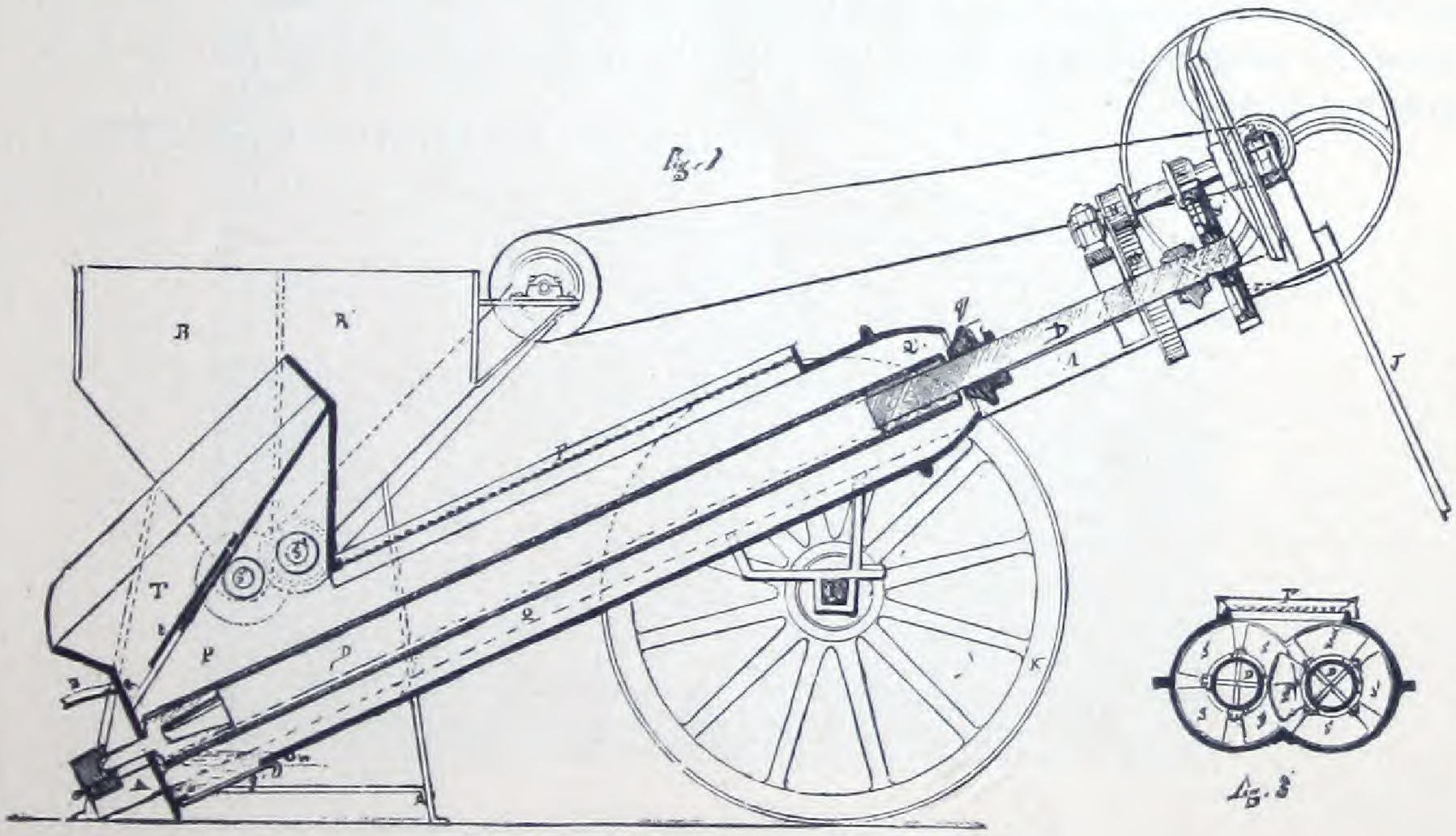


Fig. 2

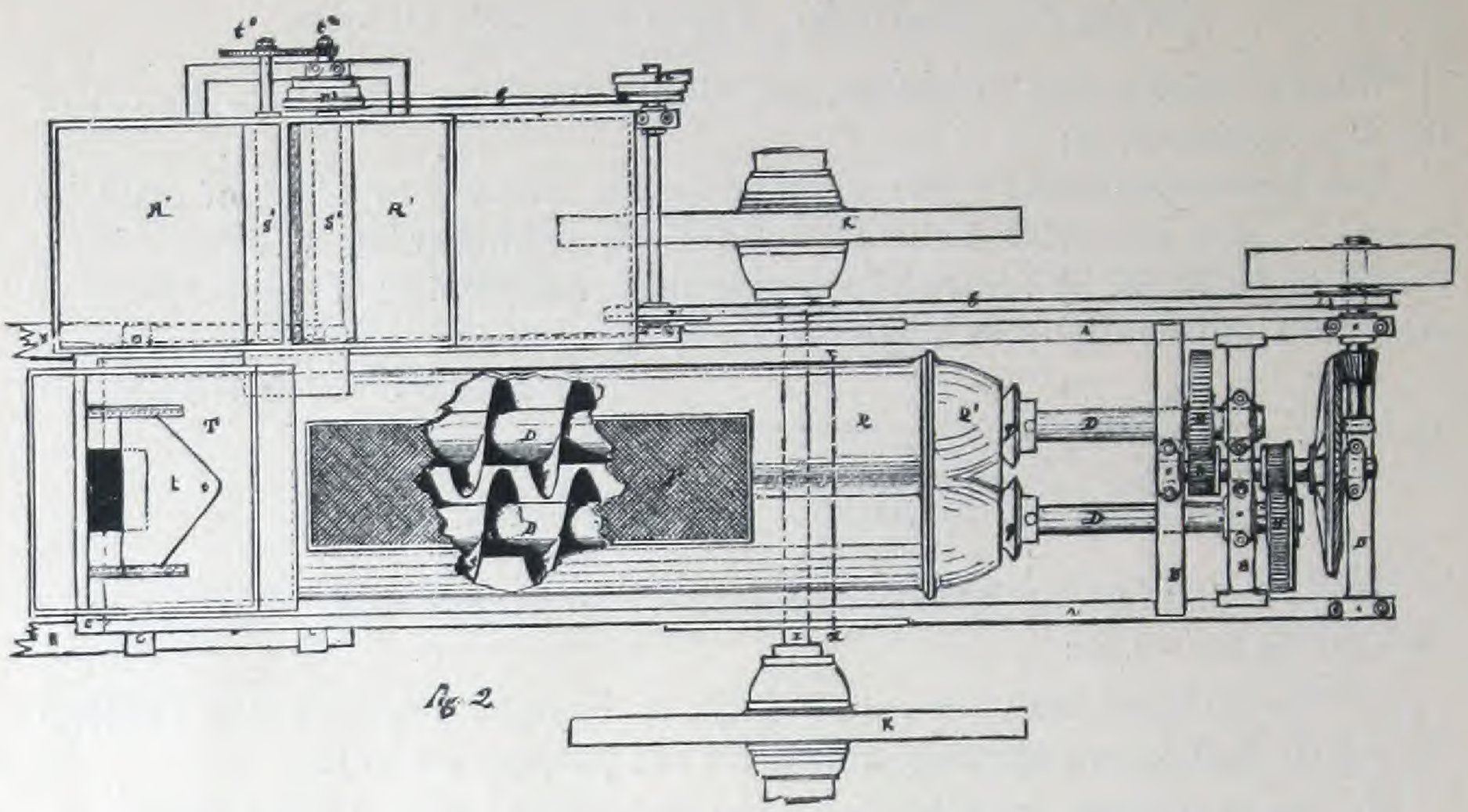


Fig 2.

Patent No. 98,035.

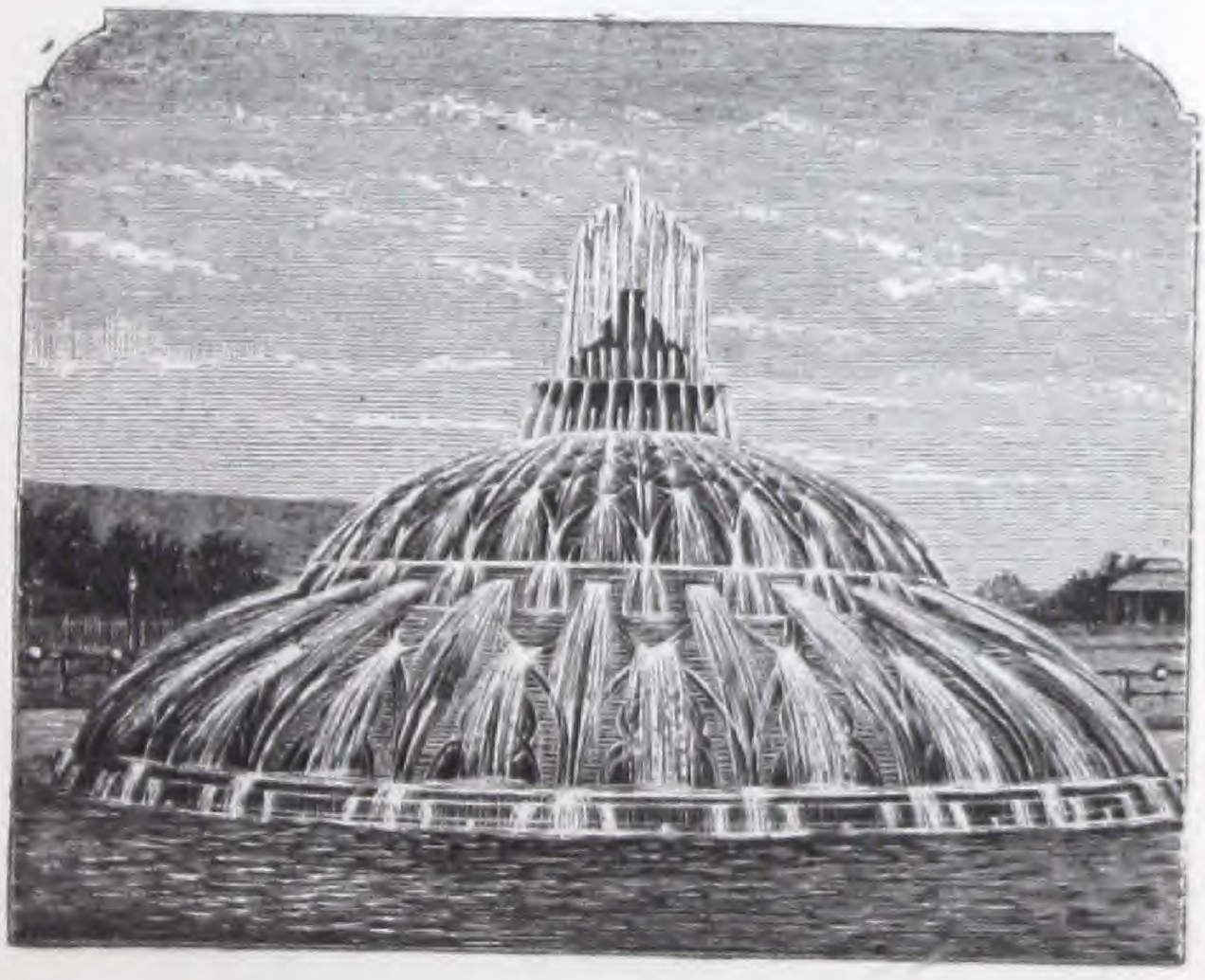
Patent No. **99,062.** Dated January 25, 1870.

To all whom it may concern:

What I claim as my invention, and desire to secure by Letters Patent of the United States, is:

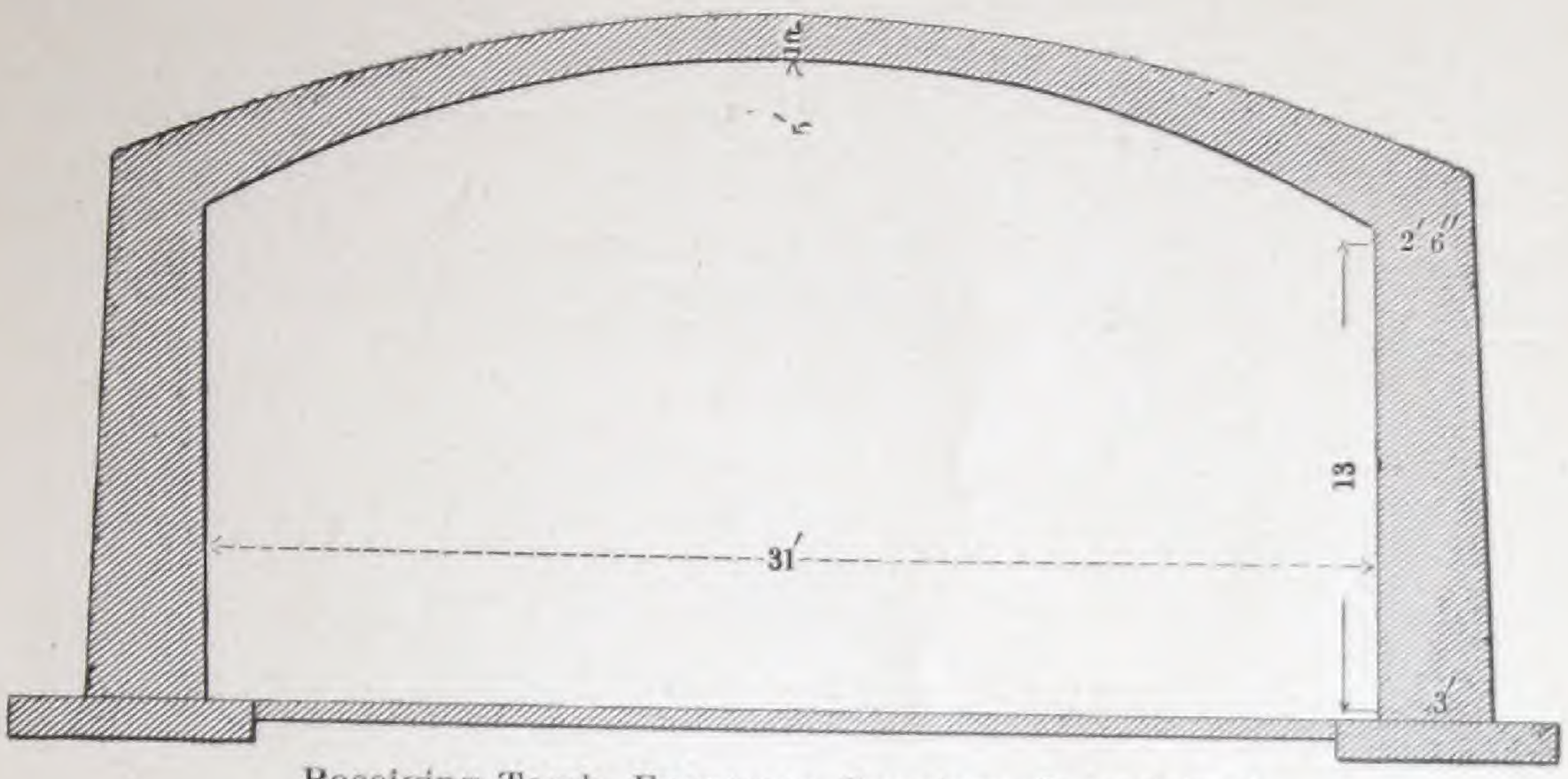
The process, or combination of the several physico-chemico-mechanical means, above described, of employing fat lime, or common lime, in artificial stones or monolithic structures, substantially in the manner and for the purpose set forth.

FRANCOIS COIGNET.



Fountain on Plaza, Entrance to Prospect Park.

Third Ave. cor. Third St., Brooklyn. N. Y.



Receiving Tomb. Evergreen Cemetery, Long Island.

James Renwick, Architect.

New York Stone Contracting Co.

ADDRESS

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PRESIDENT,

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